

all about **Homebuilt Aircraft**

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By the Editors of Plane & Pilot Magazine

All About Homebuilt Aircraft



WERNER & WERNER CORPORATION, SANTA MONICA, CALIFORNIA

Introduction



SPORTS PLANE FLYING today is enjoying an unprecedented boom in popularity and promises soon to become one of the biggest single facets of General Aviation in America, Canada and in some countries abroad — and if one includes all privately-owned aircraft flown for pleasure rather than business, the bulk of the General Aviation fleet can properly be called sports planes.

While the greatest number of ships in the General Aviation fleet will be four-place single-engine craft, the FAA looks for the current rising trend in pleasure flying to continue. Special categories are now being established for aircraft specifically designed and built for sport flying.

It is this basic freedom of flight that appeals to so many — a return to the early-day excitement of barnstormer and gypsy pilots, who flew for the love of it and brought aviation to grassroots America. And to still earlier "homebuilt" enthusiasts like the Wright Brothers, who first faced the challenge of the sky and won.

One of the nation's most active sports plane groups is the Experimental Aircraft Association, which today numbers close to 50,000 members at home and abroad. It hasn't really been too long since flying machine inventors were laughed at, and kids used to yell derisively: "Your daddy thinks he can fly!" Today, flying machine design is a serious if

delightful undertaking. Highly skilled professional engineers and pilots work in barns, attics and backyards, side-by-side with younger enthusiasts who not too long ago were making model airplanes. In fact, aircraft modelers already are trying out new aerodynamic ideas and structural designs which they may incorporate in future homebuilts that inevitably will establish new records for speed, range and endurance.

It is this universal appeal of sports flying that accounts for so many people of all ages and all walks of life turning to aviation for other than business or professional reasons. Gliders and soaring planes, rotorcraft and racing planes, antiques, amphibians, and homebuilts all offer something in common — a release from the humdrum world and a chance to enjoy feeling akin to birds in their element — the sky.

In this country, sports plane enthusiasts compete for prize money in both closed-course and cross-country races with specially designed or modified racing aircraft, under direction of the Professional Race Pilots Association, an affiliate of the National Aeronautic Association.

In this book, it is hoped the sports plane enthusiast, whether an active pilot or a newcomer to aviation, will find in the background of this fascinating hobby, a reason to join others now building or flying their own aircraft. It's a new way to discover flying!

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The World Of Homebuilts

WHO, ME? Build an airplane?!!!!

That's the first reaction of a great many would-be pilots whose desire to fly is frustrated by the high cost of buying or renting a "store-bought" flying machine.

At the mere mention of a do-it-yourself project they conjure up images of rickety contraptions made of bamboo and old sheets, or shudder at the prospect of intricate design formulas, huge investments and complex fabrication techniques beyond the skill of any but an expert.

All this is very sad, because the simple truth is that these ideas are all wet. Homebuilt aircraft can be, and usually are, stronger and better built than factory-produced machines. They usually outperform production airplanes with the same engines, often by great margins. And with most of the plans and kits available for sale, any tolerably patient person can produce a first-class airplane in his basement or garage in a couple of years or less of spare time work.

High-performance homebuilts have been built by wives and grandmothers, by beginners who had never built anything before and didn't even know how to fly, and by ordinary folks like you and me. Generally the total cost runs below \$2,000: relatively few homebuilts exceed \$5,000, and this is less than half the cost of the lowest-priced factory airplane you can buy.

An additional advantage of a homebuilt is that you can perform your own maintenance and repair work even if you're not an aircraft mechanic, and this represents a formidable saving over the operation of a certificated aircraft. A good many homebuilts are flown for fun on weekends, then trailered home and stored in the garage to avoid hangar costs which often reach \$50 to \$75 per month in metropolitan areas. Other advantages accrue, as well: often the particular type of plane a pilot wants simply is not manufactured commercially, and the only way to get it is to build it. People who enjoy expressing their individuality find that a distinctive homebuilt attracts far more attention than even the fanciest factory plane. And a homebuilt is your passport into the fascinating world of airplane people, that delightful crowd of fun-lovers who foregather at stated times and places to admire one another's flying machines, tell stories of great derring-do (and sometimes colorful, epic lies) and make swooping motions with their hands to show how they executed a perfect chandelle or shot down the Red Baron.

The biggest advantage of all, however, is that it is simply more fun to build and fly your own airplane than it is to buy one from the factory, and fun is what flying is all about.

Reduced to essentials, people who fly can widen their recreation horizons far beyond the reach of even the most diligent motorist. You can drive 600 miles to a ski resort, sports event or sunny beach in 12 hours: you can fly there in four or five. And if you don't have the \$10,000 to \$30,000 or more that a new plane would cost, you can build your own new plane for a fraction of that amount, spread over the construction period in bearable chunks.

There are three basic construction materials commonly used in homebuilt aircraft: wood, welded steel tubing and fabricated sheet metal. Wood or welded tube skeletons may be skinned with fabric or thin plywood. "Fabric" used to mean cotton or linen with a limited life, but modern synthetic fabrics are far stronger and so durable that with proper care some will last the life of the airplane.

There are advantages and disadvantages to each method of construction: every aspect of an airplane is a compromise. Most store-bought airplanes are made of metal, though a few have fabric covering and one has a wood wing. Metal is strong, light and can't get termites or dry rot, but it can and frequently does, corrode and it is subject to metal fatigue. Some homebuilders who want a metal design but don't own or know how to use a welding torch do the cutting and fitting of the parts themselves and hire an expert to weld them up. Wood is a more familiar and less intimidating medium to many prospective builders, and aircraft woods are stronger weight for weight than metal, but care must be taken to prevent decay. With modern epoxies, fiberglass and care, a lifetime wooden airplane can be built. Wood and fiberglass are ideal for seaplanes and amphibians, which suffer much from corrosion when made of metal.

Many builders combine the basic techniques. Wings with spruce spars, wood ribs and fabric cover are common on welded steel tube fuselages. Some homebuilts have a steel tube cabin or cockpit structure, with a sheet metal rear fuselage and tail assembly. Virtually any combination is possible, and what is used depends on what the builder wants.

Today, new plastic, foam, and fiberglass materials are coming into wide use in the homebuilt movement, in such craft as the Vari Eze, KR-1 and KR-2.



Happy Homebuilts



PAUL H. POBEREZNY, president of the Experimental Aircraft Association, estimates that some 7,000 homebuilt aircraft are currently taking shape in garages, living rooms, attics, cellars, barns — and even hangars — all over the country. Completion dates may be years in the future, but the age-old urge to take to the sky in a homemade device is as strong today as ever before.

According to FAA records, as of December 1973 there were 6,329 experimental aircraft registered in the U.S., 2,846 of them on active flying status. The number increases about 300 a year, and there is growing interest in the hobby. As is to be expected, balmy southern California is the capital of amateur aircraft construction, followed closely by Ohio and the central Midwest.

What kind of people build their own aircraft? "Butchers, bakers, candlestick makers — doctors, lawyers and Indian chiefs," according to Poberezny. The Experimental Aircraft Association has 500 active chapters, 49 of which are in Canada and other countries of the world. All told, they number 48,000 members, and growing.

In the tradition of the Wrights, Codys and Langleys, men and women with magnificent dreams are stapling, bolting,

welding, gluing, riveting, nailing and sewing together a wonderful assortment of flying machines. FAA inspectors see monoplanes in all their varied forms — low-wing, mid-wing, high-wing and parasol — with round tips and square tips and with straight, taper and delta wing plan forms. There are World War I triplane reproductions, and biplanes (open cockpit biplanes are the most popular), and even one negative-stagger biplane reminiscent of the classic Beech Staggerwing.

Materials are as varied as the planes. Amateur builders are making aircraft from wood, fabric, metal in various combinations. Fiberglass is used extensively for cowlings, fillets, wheel pants, wing tips, fuel cells and seats. One man is at work on a plane almost entirely made of fiberglass.

While FAA inspectors see an occasional "wild" concept in aircraft design, the overwhelming majority of builders produce conservative designs based firmly on sound aerodynamic theory and practice, and their fabrication methods and techniques follow tested and proven shop practices.

The typical amateur aircraft builder is generally motivated by two strong desires: the urge to fly and the high cost of a factory-made plane. The material cost of the homebuilt



Jim Osborne's fine Acroduster I carried field of stars on early paint scheme.



Rim Kaminskas designed this J-2 parasol monoplane, with fuel tank slung below.



Ed Marquardt gave wings to his imagination in designing this hot biplane, Charger.

aircraft is relatively low, running about \$1,500 to \$2,000 for a single-engine, two-place monoplane. The labor is "free" as no amateur builder counts it in his final estimate of cost, but it takes the average enthusiast about three years of part-time work to complete his pride and joy.

Who can build an aircraft? (The designation covers airplanes, gliders, free balloons, helicopters and gyroplanes.) According to Federal Air Regulations, anyone seized with the desire may build his own aircraft, regardless of his expertise with tools or aeronautical knowledge. In actual practice, most homebuilders have some connection with the aircraft community. Not a few of them are high-time airline and military pilots; some are either professional or self-taught designers, whose aeronautical ratings cover the board.

The FAA does have some rules, however, to guide the aspiring aircraft builder along the road to earning an experimental certificate for his creation. The basic rule is that the aircraft must be at least 50 percent fabricated and assembled by persons who undertook the project solely for their own education or recreation.

This is not as tight a frame as might be supposed. The amateur builder is permitted to buy engines, commercially made propellers, rotor blades and hubs, wheels and brake assemblies, and aircraft hardware such as pulleys, fasteners, tubing and extrusions. He may also incorporate structural components of other aircraft, and use raw material construction kits — provided he has fabricated and assembled the major portion of the aircraft for education and recreation.

A word of caution: if an aircraft is assembled from a kit composed completely of prefabricated components and parts, pre-cut and pre-drilled materials, FAA will not award it a certificate as an amateur-built aircraft. FAA is serious about its requirement that the major portion of the aircraft be fabricated and assembled by the builder.

Before a stick of spruce or a yard of fabric is purchased, amateur aircraft builders are encouraged to visit their local FAA office to talk over their projects. But there is no rule that says they must. Strictly speaking, an aircraft could be built from conception to roll-out without any in-progress inspection by FAA. But this would delay certification considerably.

Before granting a homebuilt aircraft an Airworthiness Certificate, FAA must determine that the aircraft is not a deathtrap, that it is constructed of quality materials, and put together with care in accordance with sound techniques. Without the FAA airworthiness certificate, the aircraft becomes an expensive grounded monument to frustration.

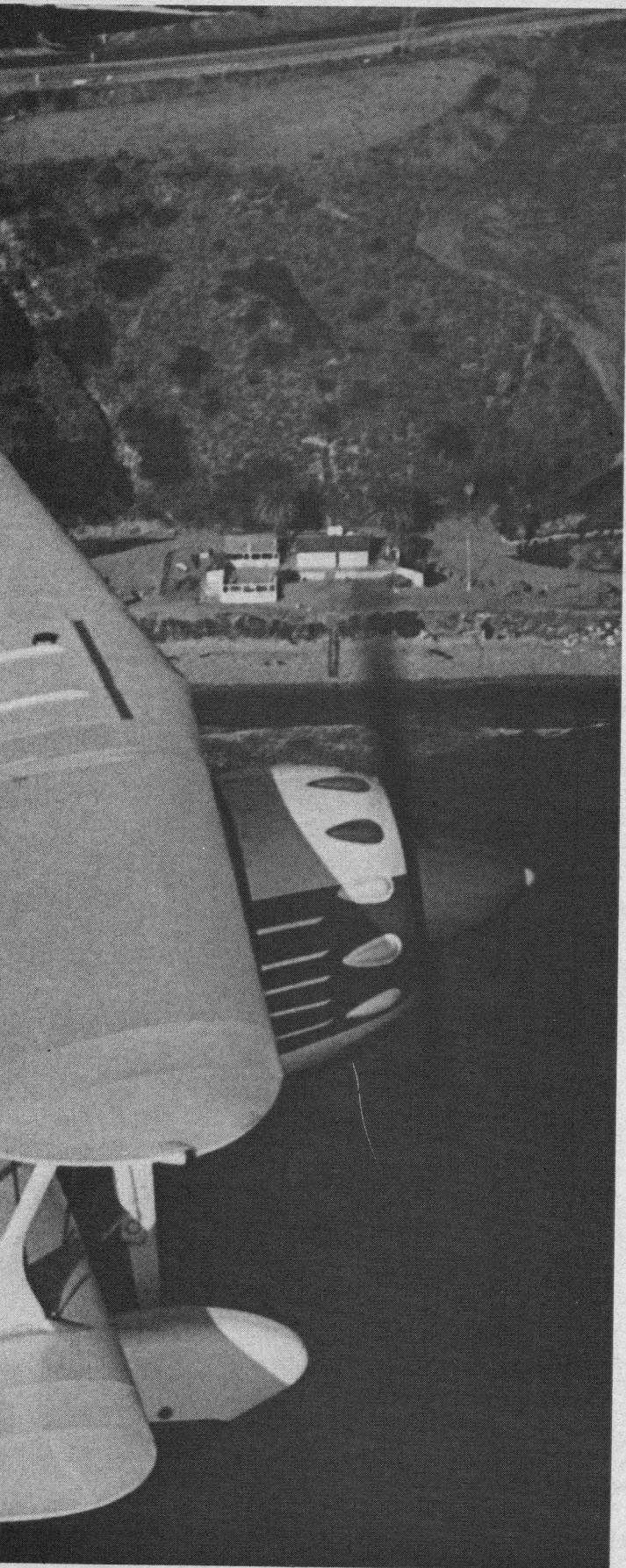
In-progress inspections present no practical problems and often result in constructive suggestions that save time and money and, more important, contribute to a safer product. FAA representatives will schedule periodic inspections so that the aircraft gets a good going over in stages as it evolves. Thus, wings and fuselages are examined before external covering is applied or before an area is permanently closed. In order to speed the inspection process, and to minimize questions about material specifications, type, quality, and source, builders are advised to keep invoices



*You can take your best girl for a ride
out in the open in a Breezy flying machine.*



Starduster Too with radial engine makes a hot aerobatic sports plane for two.



and shipping documents on permanent file.

The broad outlines governing construction of amateur-built aircraft are contained in Advisory Circular AC 20-27A "Certification and Operation of Amateur-built Aircraft," available free from the Department of Transportation, FAA, Distribution Unit, TAD 484.3, Washington, D.C. 20590.

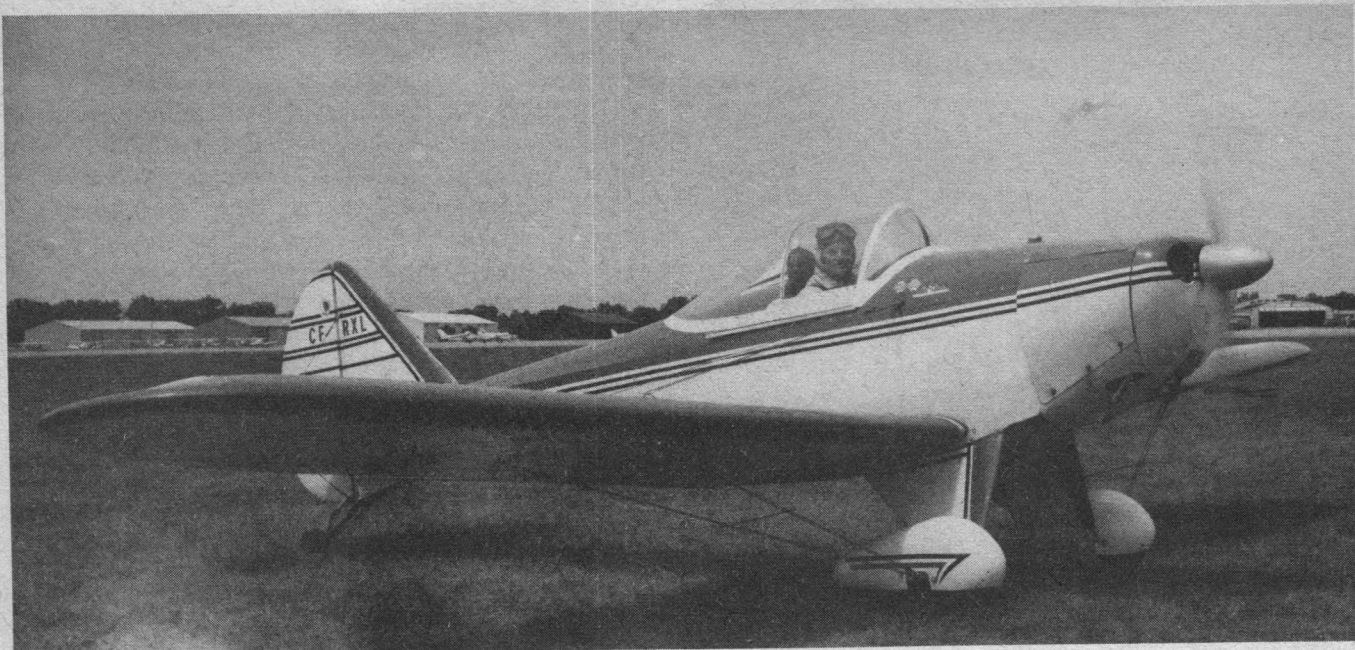
FAA has an open mind as far as what goes into constructing an aircraft. For example, any kind of engine, propeller, wheels and other components may be used at the discretion of the builder. Modified Volkswagen, lawn mower and ground power unit engines have been used successfully in aircraft, and some farm implements yield wheels and tires adaptable to airplane use. While FAA regulations do not point a stern finger and say you must use this, that and the next thing in your aircraft, the wisdom of using FAA-approved components and "aircraft quality" materials in such critical members as wing spars, attachment fittings, engine mounts, landing gear and other structural members is obvious.

Similarly, instrumentation is left up to the builder. The aircraft must be equipped with at least the basic flight and engine instruments. Before the first flight, FAA recommends that the engine be given an operational check of at least one hour, with the engine running from idle to full power. Builders are advised to stick to the grade of fuel recommended by the engine manufacturer, and the plane should be tilted in various angles (simulating flight attitudes) to verify full and uninterrupted flow of fuel from tank to engine.

Accompanying the airworthiness certificate is the requirement to placard the aircraft with the word "experimental" painted near the entrance to the cabin or cockpit in plainly legible letters not less than two inches or more than six inches in height. A standard restriction limits early flights to the environs of outlying airports and away from population centers. The usual "try out" time in a restricted flying area for an aircraft with a certificated power plant is 50 hours; 75 hours for an unproved engine.



Ron Wier's Draggin' Fly is the ultimate in outdoorsmanship — a flying bathtub!



Peter Bowers' Fly Babies come in several varieties, like this Canadian version.



Marcel Jurca designed this hot little MJ-1 Gnatsum (Mustang spelled backwards).



This one-of-a-kind homebuilt parasol is an HCF-4, the work of Henry C. Foster.

Before a pilot is free to roam far and wide in his homebuilt aircraft, he must have an "operating limitations certificate" to permit flight out of the restricted area. Typically, operational limitations describe the airplane, state that it is homebuilt, in the experimental category, and built for personal transportation and recreation. Commercial activity is ruled out, and passengers are limited to personnel essential to flight. The standard final sentence carried the notation that any deviation from operation limitations or any major change in the aircraft will cancel the Airworthiness Certificate.

Airworthiness Certificates issued for "Experimental" category aircraft must be renewed annually, in contrast to the indefinite certificate awarded to factory made aircraft. The aircraft must be registered and the "N" numbers painted on before the first flight.

Flying the homebuilt creation is best approached with caution and must follow the rules laid out in FAR 91, "General Operating and Flight Rules" — with one exception. If the homebuilt aircraft is a gyroglider and flown while attached to a ground or water based vehicle it is considered to be a kite and comes under the provisions of FAR 101, "Moored Balloons, Kites, Unmanned Rockets, and Unmanned Free Balloons."

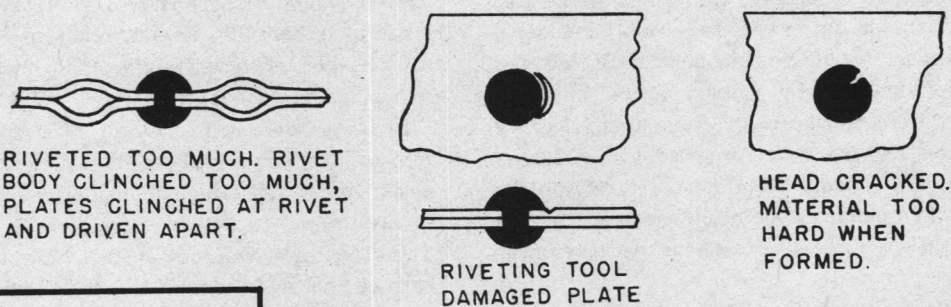
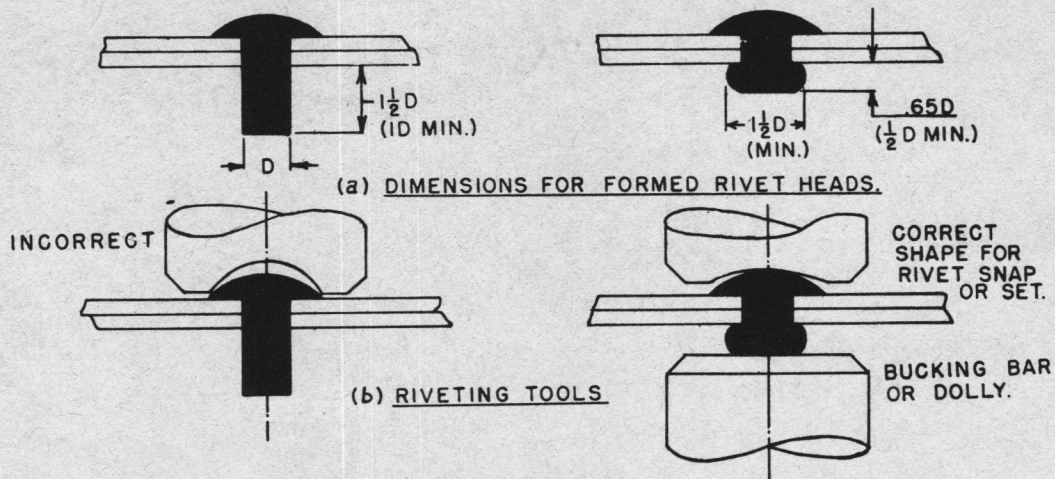
Building an aircraft from the ground up does not automatically qualify the maker to fly it. He must be licensed as a

pilot under FAR Part 91. Numerous taxi tests, at increasing speeds, should be performed before any serious attempt is made to actually fly. Even the big aircraft companies with their elaborate design staffs and well-equipped factories, test out a new aircraft on the ground first.

Flying a rotorcraft is totally different from operating a conventional airplane. Free flight in a rotorcraft should not be attempted until the plane has been tested while tethered to the ground to restrict its movement up and sideways. Tethered tests will demonstrate stability, vibration and balance characteristics of the craft and will give the pilot actual practice in handling its peculiarities while the plane is close to the ground.

The actual flight test program should be planned to move carefully from the familiar to the unknown. This includes slow flight with stalls, engine-cooling climb tests, and similar maneuvers. The very last thing to be tried are aerobatics or violent maneuvers.

"Amateur," as it applies to the "amateur" airplane makers in the U.S., does them an injustice in view of the sleek, finely tuned creations being rolled out of barn, bedroom and cellar workshops. The urge to give wings to one's dreams has created a major industry in the U.S., and the ingenuity and patience displayed by many amateur builders is still contributing useful knowledge to aviation. Of necessity, FAA keeps a watchful (but fond) eye on them.



(C) RIVET IMPERFECTIONS.



(A) INCORRECT



(B) INCORRECT

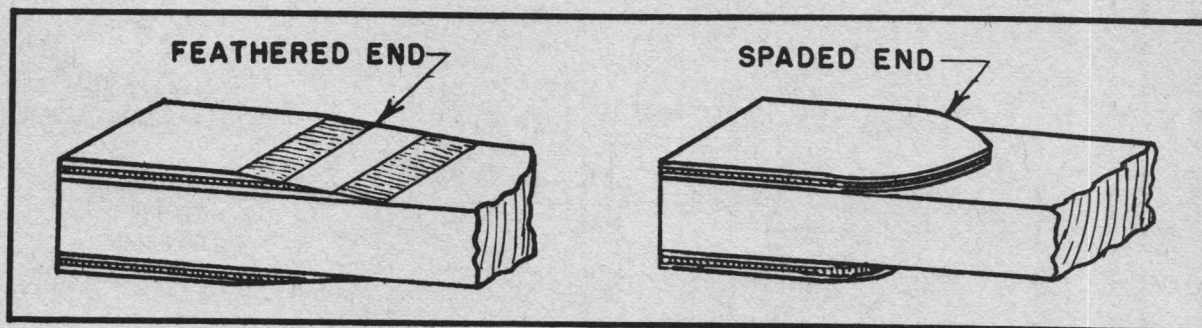


(C) CORRECT

Riveting practice and rivet imperfections.

Consideration of grain direction when making scarf joints.

Trouble Saving Tips For Homebuilts



AN UNPRECEDENTED proliferation in homebuilt aircraft construction and antique aircraft restoration is providing a new challenge to the skills of America's backyard do-it-yourself enthusiasts. Many of the thousands of current amateur builders are designing and putting together sports planes with no prior experience or knowledge in aircraft construction.

This problem is faced today by the Flight Standards Service of the Federal Aviation Administration in a way designed to encourage and give the widest latitude to creativity consistent with safety. In its Advisory Circular AC 20-27A, for example, it is clearly stated that "any kind of materials may be used in the construction of an amateur-built aircraft," while advising that FAA approved components and established aircraft quality material be used wherever possible.

Once completed, a homebuilt must pass FAA inspection before an airworthiness certificate will be issued for legal flight. Hence, it is recommended that the amateur builder discuss his project first with a Flight Standards Service expert, to avoid the disappointment of a turndown because of poor design, material weakness or faulty construction technique. Repairs, alterations and restorations of antique aircraft also must pass muster before such aircraft can be licensed to fly.

One of the best guides to proper homebuilding is the FAA's Advisory Circular AC 43.13-1, obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, under the title: **Acceptable Methods, Techniques, and Practices — Aircraft Inspection and Repair**. In this 232-page manual may also be found a

wealth of useful information on the kind of materials to select, repair or utilize in construction. Here is a sampling:

Woodworking

Bulk of all wood aircraft construction materials are either solid wood, plywood or laminated wood. Excellent for all aircraft uses is spruce, with a maximum allowable grain slope of 1:15. To reduce shrinkage effects, the FAA recommends feathering or tapering plywood face plates as shown. In repairing control surfaces of antiques, be careful not to increase weight aft of the hinge line, which could produce flutter.

Glueing

A good glue joint is as strong as the wood under all conditions of stress.

Never use sandpaper to smooth softwood surfaces for glueing.

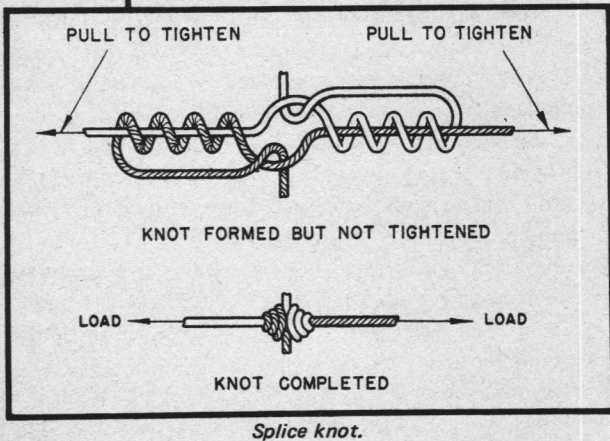
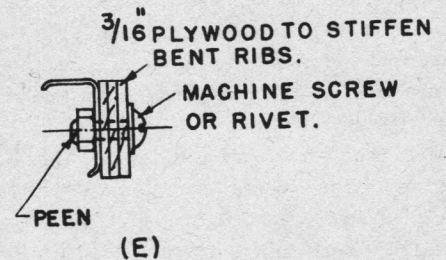
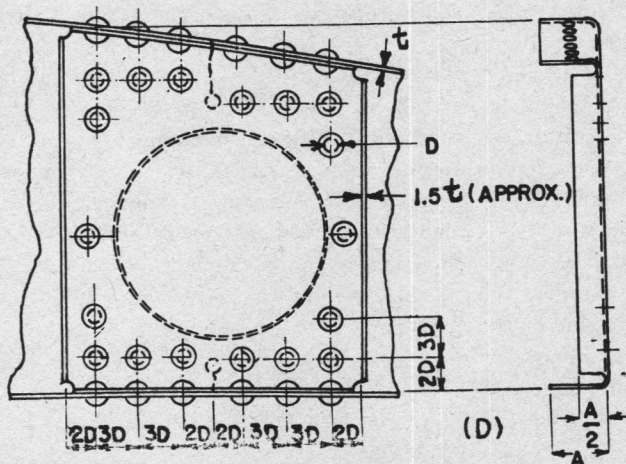
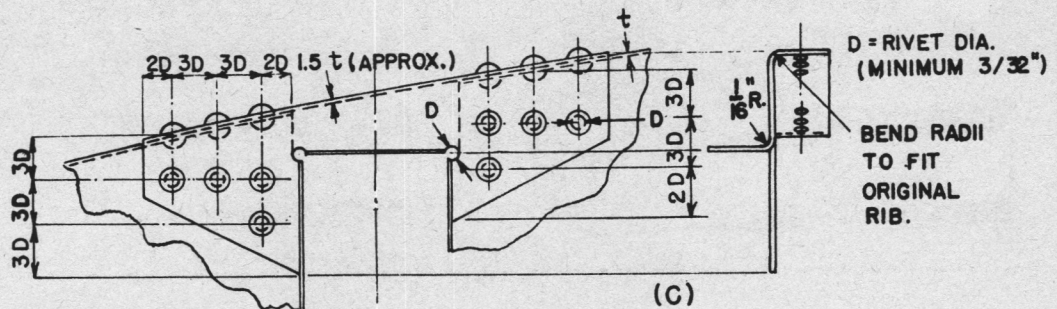
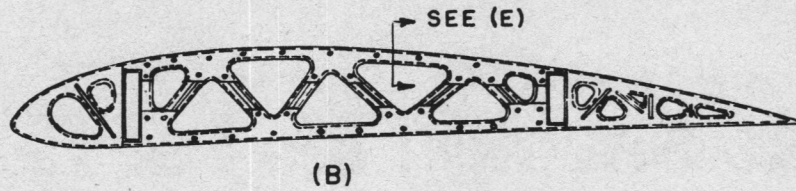
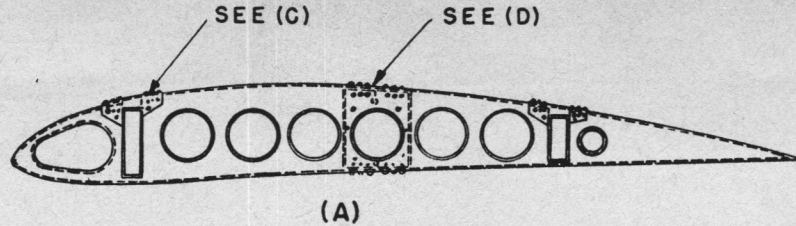
Two types of glue may be used — casein or resin. Recommended is resorcinol-formaldehyde resin glue, as strong, durable and waterproof.

Glue should be spread evenly on both surfaces with a clean brush, the joint held under pressure for seven hours or more at a temperature not less than 70 degrees F.

Hand nailing can be used in glueing ribs and in applying plywood skins to wing, control surfaces and fuselage frames.

When making scarf joints, cut parts accurately and fit with grain-slopes matching.

A spar may be spliced at any point except under wing attachment, gear fittings, engine mount fittings or lift-and-interplane fittings.



Typical metal rib repairs (usually found on small and medium-size aircraft).

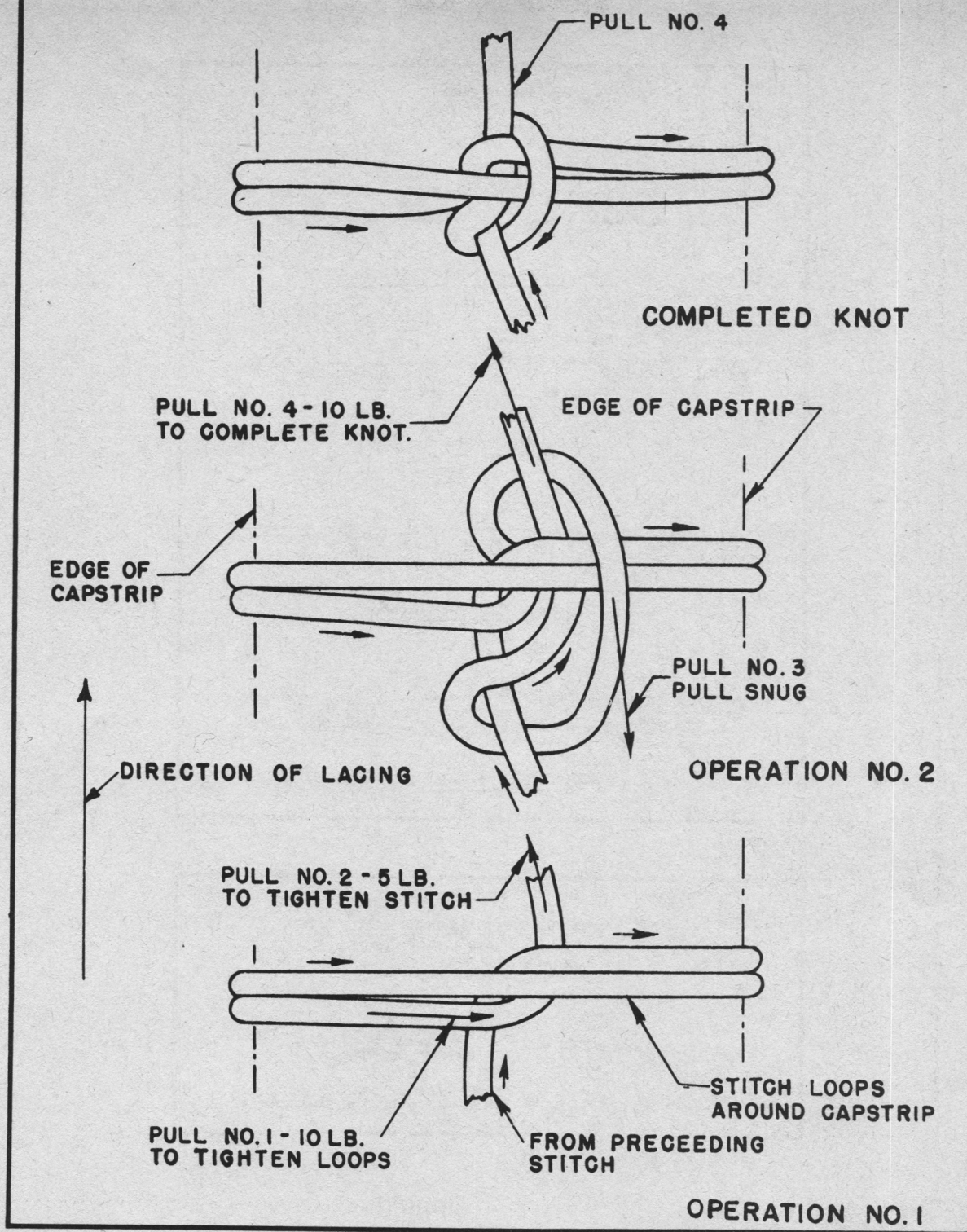
Wood Finishing

Avoid glue squeezeout on all surfaces. Paints and glues are incompatible; a small amount of glue underneath the finish may cause it to peel.

Vacuum out all sawdust, shavings and chips before sealing off an enclosed area.

Finish new or repaired ribs, spars, plywood skin interiors and other internal members with at least two coats of spar varnish.

Exterior surfaces should first be sealed with at least two coats of sealer or spar varnish before applying enamel, aluminized varnish or other finish.



Standard knot for double loop lacing.

Metalworking

Always repair metal control surfaces in a way not to change weight distribution, which can cause flutter.

Never braze primary aircraft structures unless originally approved before brazing.

Not all alloy steels are weldable. The following are: plain carbon of the 1000 series, nickel steel of the SAE 2300 series, chrome-nickel alloys of the SAE 3100 series, chrome-molybdenum steels of the SAE 4100 series, and low nickel-chrome-molybdenum steel of the SAE 8600 series.

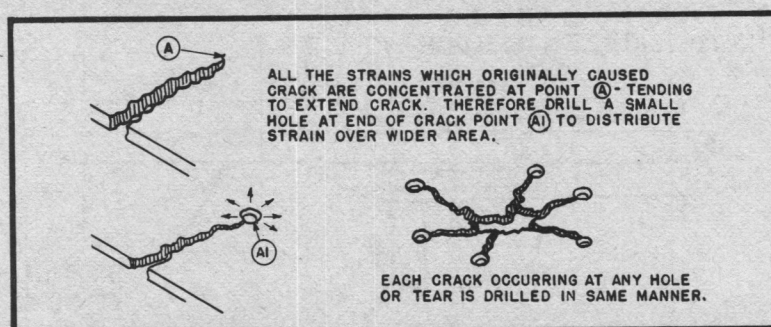
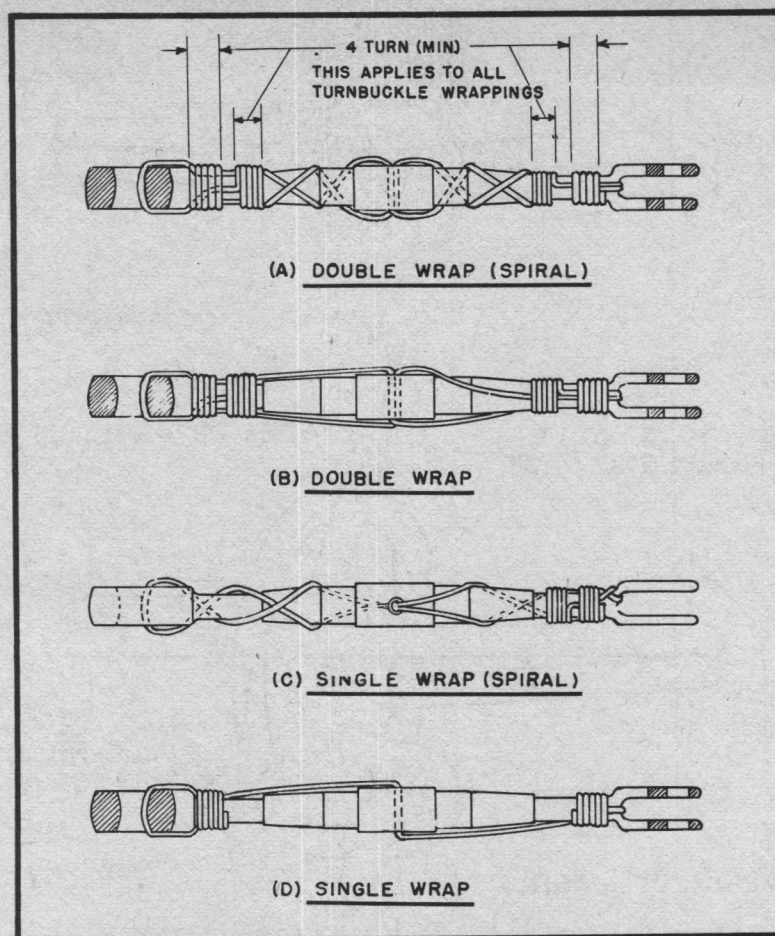
Do not file welds to smooth them; this weakens joints. Do

not fill welds with solder, brazing metal or other filler. Avoid welding over a weld; reheating may cause material to become brittle. Never weld a joint previously brazed. Do not weld brace wires or cables.

Riveting

Drill rivet holes round, straight and free from cracks. Do not substitute hollow rivets for solid rivets in load-carrying members without FAA approval.

Damaged aluminum alloy ribs may be repaired by addition of suitable reinforcement.



Fabric Covering

All fabric, surface tape, reinforcing tape, machine thread, lacing cord, etc., must be high-grade aircraft textile material.

Proper preparation of structure to be covered is essential. Treat all parts which come in contact with fabric with aluminum foil, dopeproof paint or cellulose tape.

Cover all sharp edges, boltheads, etc., with doped-on fabric or adhesive tape.

Either envelope or blanket method of covering may be used. Place reinforcing tape on all capstrips beneath lacing.

Securely fasten both surfaces of covering to ribs by lacing cord or other approved method. Use splice knot to join lengths of lacing cord; keep tension uniform. Double-loop lacing gives greatest strength.

Doping

Dopes come with proper consistency for brushing — thin for spraying. Apply as many coats as needed for a taut, well-finished job, by one of the following methods:

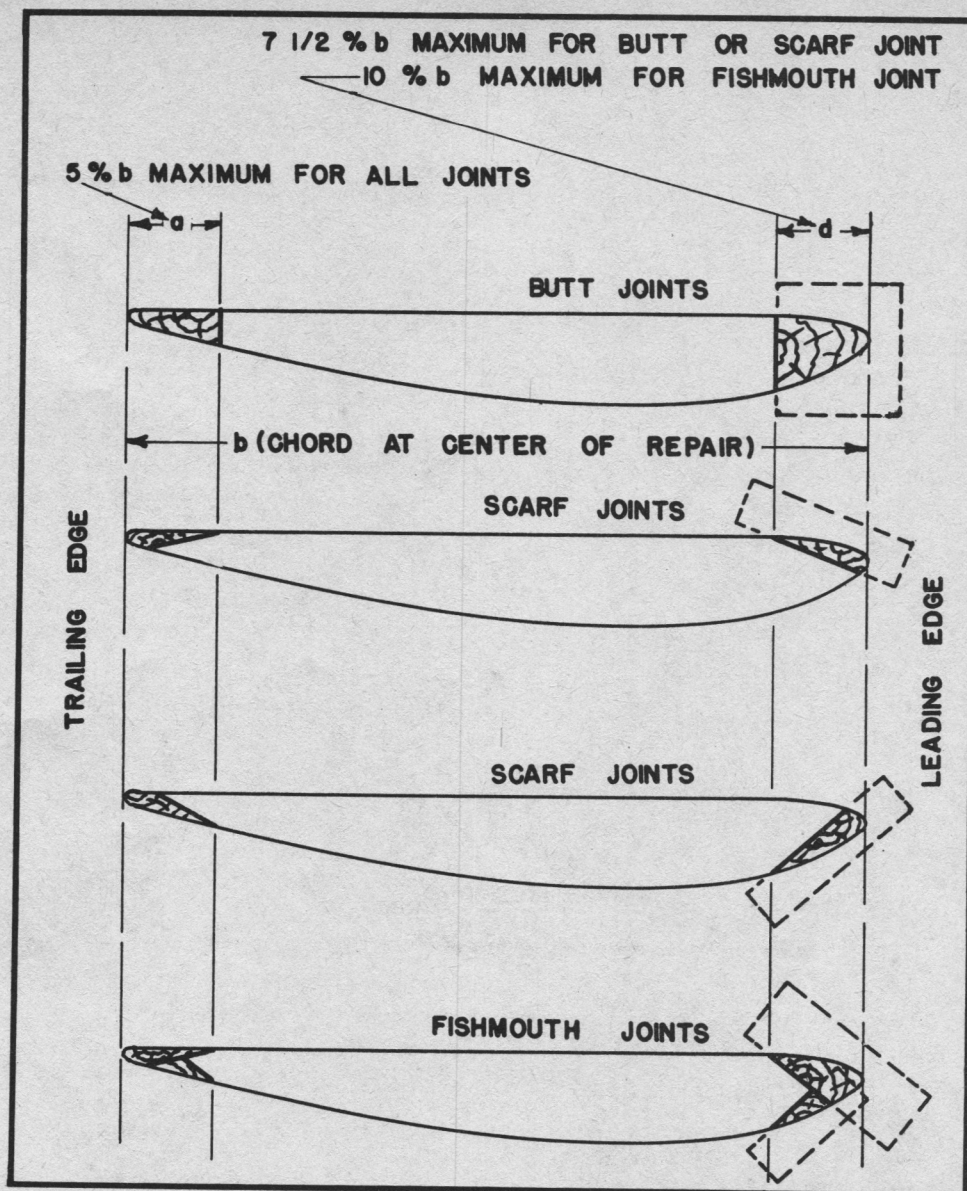
a. Two coats of clear dope, brushed on and sanded after second coat.

b. One coat of clear dope, either brushed or sprayed, and sanded.

c. Two coats of aluminum pigmented dope, sanded after each coat.

d. Three coats of pigmented dope (color desired), sanded and rubbed to give smooth, glossy finish.

e. Do not sand heavily over center portion of pinked tape or over spars, in order not to damage rib-stitching cord and fabric.



Turnbuckles

Safety all turnbuckles with new safety wire (never reuse!) by either double or single wrap method.

Inspection of Metals

Careful examination of all joints with a medium-power magnifying glass (at least 10 power), after removal of all scale, is acceptable for inspection of repaired structures.

Plastics

Two types of plastics commonly used for aircraft windshields and windows are acrylic and polyester plastics.

Never force a plastic panel out of shape to make it fit a frame. Heat whole panel and reform, or cut and fit new panel at room temperature.

Mount plastic panels between rubber, cork or other gasket materials to make installation waterproof, reduce vibration and distribute compressive stresses.

Mount windshield panel deep enough to prevent its falling

out when panel contracts in cold weather or deforms under load.

At first signs of crack development, drill small hole at extreme end of crack, to prevent further splitting by distributing strain over larger area. If crack is extensive, replace panel.

Propellers

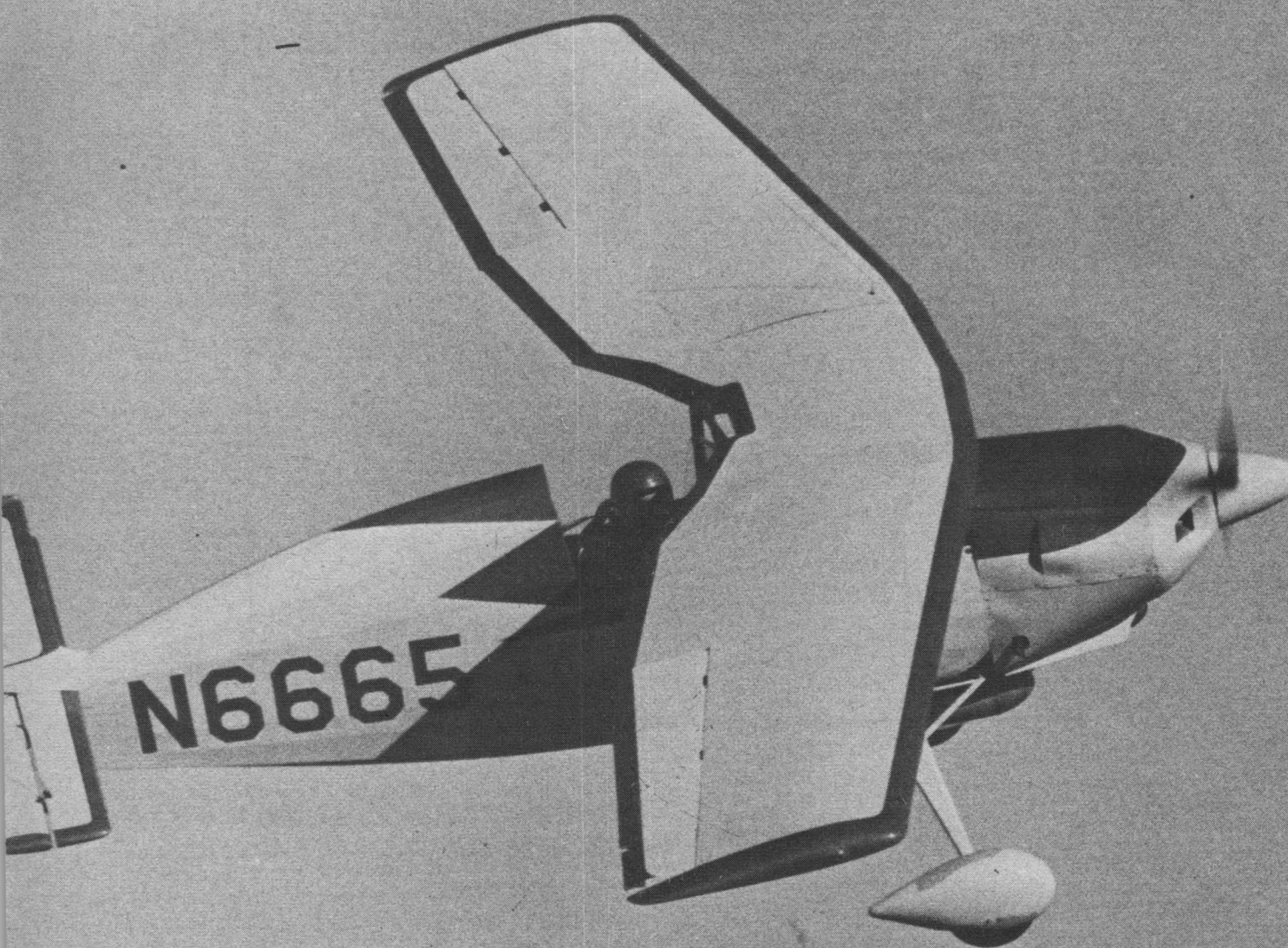
Periodically inspect wooden propellers for cracks, bruises, scars, warpage, evidence of glue failure and separated laminations, broken sections and defects in finish.

Small cracks parallel to grain may be filled with glue, worked in thoroughly, dried and sanded flush.

Dents or small scars may be filled with mixture of glue and clean, fine sawdust.

Blade inlays should be of same wood as propeller blade and as near the same specific gravity as possible.

Always check propeller's balance after repairing or re-finishing.



Flight Testing Your Homebuilt

YOU'VE JUST SPENT two of the happiest years of your life putting together your backyard bomber. A homebuilder's dream. A carport contraption that takes your breath away just to look at it. Silver wings... sleek fuselage... a throaty engine that really purrs.

But now your wife is tapping her foot and asking: "Honey, when are you gonna get that thing out of here and into the air? I need the space for our new clothes dryer!"

It suddenly dawns on you, the past months have been spent on a project that was so much fun you've almost lost sight of the big goal — actually flying it! Now it's time to put away your hammer and saw, sweep the sawdust into a corner, and trail your beauty to the airfield.

If you're like the majority of homebuilders, you can't afford to put money into a construction project and own a viable airplane on the side, hence you're probably a little rusty at the controls. So before that first flight you've got to make a decision — either go buy yourself some refresher time, or call on a qualified, current pilot to take her up for the first flight, while you stand on the sidelines biting your nails.

No matter who makes the first test hop, it can't happen until the FAA has completed all necessary inspections, even though your bird is painted with the word EXPERIMENTAL. Nothing flies today without FAA approval. This is their guarantee that you have done a reasonably good construction job, and put together something that won't fall apart. (Contact your nearest FAA General Aviation District Office or Aircraft Engineering District Office, for further details on approved flight test procedures).

When you're sure your paper work is in order, including a competent weight-and-balance check, your flight test program gets under way — cautiously. Ever since the Wright Brothers first flew at Kitty Hawk, the requirement for an incremental, step-by-step flight test program has been known, and properly followed, it leads to a safe checkout.

The Wrights, incidentally, judiciously learned to fly long before that first historic hop down the sand dunes of Kill Devil Hill on December 17, 1903. Both Orville and Wilbur had already logged a number of flights in man-carrying kites and in gliders before they fired up their 12-hp engine and achieved true powered flight.

The use of wind tunnels took much of the burden of proof from the shoulders of daring test pilots, a breed too often

caricatured in movies as reckless chaps who wore streaming scarves that were likely to tangle up in the rudder controls, and who made horrible terminal dives with screaming wires, while the boss's daughter sobbed down on the field.

Dives today are a routine part of flight flutter testing, but they come later in the program. At first, engine runups and taxi tests will give you an idea of how your bird will behave on takeoff and landing roll-outs.

Most important at the outset is to be sure you sit comfortably in the cockpit, have adequate vision forward, up, down, left and right, and can easily reach the rudder pedals and other controls. It's a good idea to arrange yourself with parachute, cushions, or whatever, then close your eyes and run a blindfold cockpit check, so you know where everything is.

Some pilots prefer making short straight-ahead hops prior to leaving the airport area, but make sure you have sufficient runway left ahead to roll to a stop.

Homebuilder Dick Jameson found himself in this predicament not long ago, test-hopping his pretty little Gypsy Hawk. "There I was sliding sideways in the tightest 180 I ever did!" he recalls. "I never stopped running — I just zapped around and started back down the taxiway in one glorious maneuver!" You can tear off a gear leg that way, but Jameson lucked out and today he is a wiser and safer pilot, and has logged many happy hours in his red dream ship, which he designed by himself.

Prior to takeoff, there's another way to get used to the control feel, recommended by one of the nation's top test pilots — Herman (Fish) Salmon, a veteran of many years' experience at Lockheed, and a guy who has test flown quite a number of homebuilts, including the old Goodyear Racer, the Cosmic Wind.

"A high-speed taxi run is fine on a large runway, but you can't get away with it on a short grass strip," says Fish. "With a taildragger, you can fly it standing still in a brisk breeze — just point her into the wind and see how she tends to weathercock, holding the tail up in the air.

"Find out if you have adequate response with pitch control. Do this with the brakes on, but definitely not with the wheels chocked. If it gets away from you, you can always ease off the brakes and roll forward a couple of feet to regain control. But if your wheels are chocked, you might accidentally tip over on your nose."

In the homebuilt arena, says Salmon, "there are so many different types you never know just what to expect. Sometimes the builders use too small a tailwheel, and I ask them to put on a bigger wheel, to have more traction in case of a ground loop."

Both Fish Salmon and Tony LeVier frequently switched from heavy jets, transports and bombers to the tiny Cosmic Winds, and experienced an over-control tendency they had to guard against. "When you climb out of a big airplane into a small one, you've got more of a problem than the other way around," he explains.

So, guard against over-controlling on the first takeoff, and take it "real easy" until you get to a safe altitude away from populous areas, Fish advises. "Then, when you get a little time in your plane and feel real brave, you may find she wants to root around in a turn. Return and land as smoothly as possible, and check your c.g."

Even though you think you've been flying with a forward c.g., he explains, "the plane may like the c.g. still further forward. In the Cosmic Winds, we started out with what we thought was a really good c.g., about 22 percent, but boy, we had to move it forward to nearly 16 percent."

Take all the advice you can get from anybody who has seen a similar plane fly, even some kid with a model plane who asks, "Hey, mister, is this thing supposed to be this way?"

Disassemble all the information input you can get, both from the experts and so-called non-experts, and be open-minded about what you hear, says Salmon. He recalls that a group of pilots warned the late racing ship designer, Art Chester, who had an unfortunate accident flying his **Swe' Pea**, that it appeared to be out of balance, from where they stood on the ground.

Salmon watched another homebuilder attempt a first

flight in an oddball pusher that carried the tail wheel on the bottom of an inverted tail fin, so that in three-point attitude the wing was at zero angle of attack.

"He had no way to get the tail down on the takeoff roll, and we warned him he'd really use up the runway, unless maybe he put a two-by-four on the runway, halfway down, so he could bounce into the air."

The pilot ignored the warning, rolled far down the runway before becoming airborne, then found the elevator overly-sensitive due to the high takeoff speed. He managed to regain control, then flew around the field a number of times, doing aileron rolls, while the pilots on the ground shuddered.

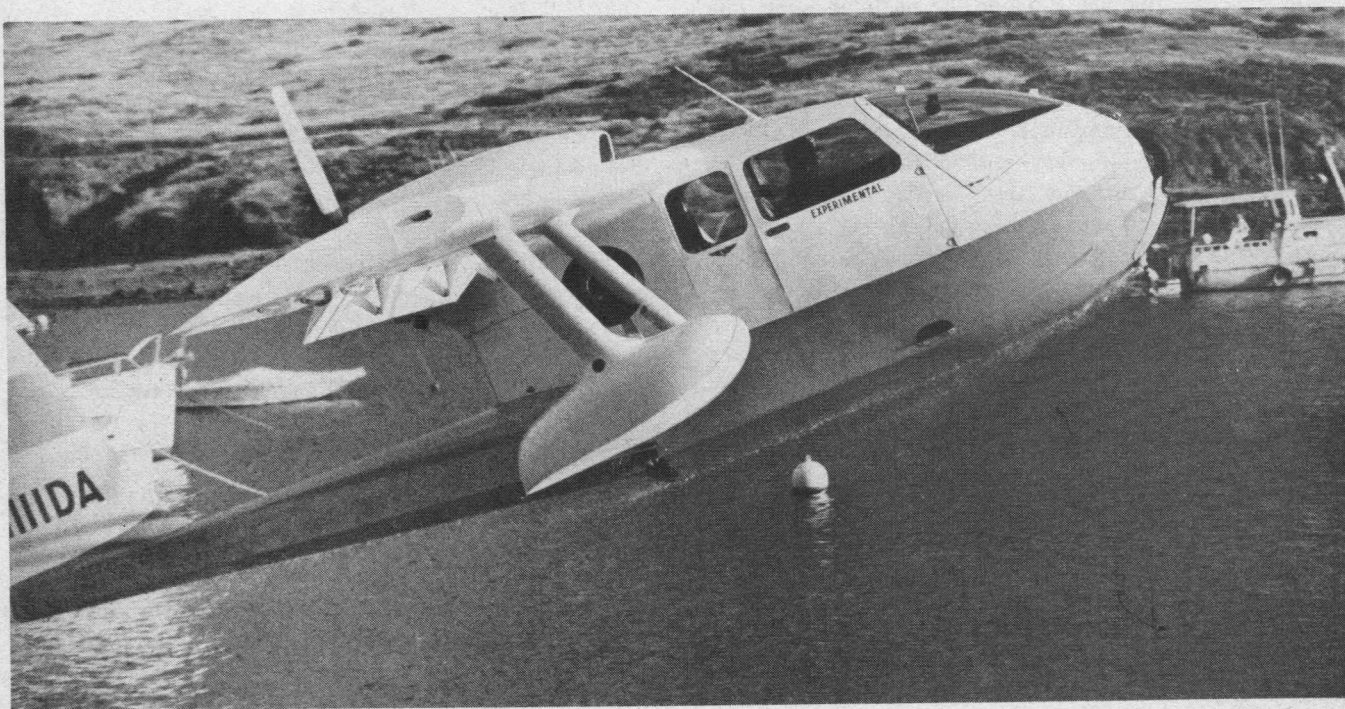
"When he came to land, instead of making a wide turn far out, he pulled it in too tight, lost control, and bailed out," Salmon remembers.

If you plan to do approved aerobatics with your homebuilt, you'll have first to demonstrate to the FAA whatever specific maneuvers you want the ship certificated to do. All aerobatics must be done at a safe altitude, over open terrain or water, with the required parachute.

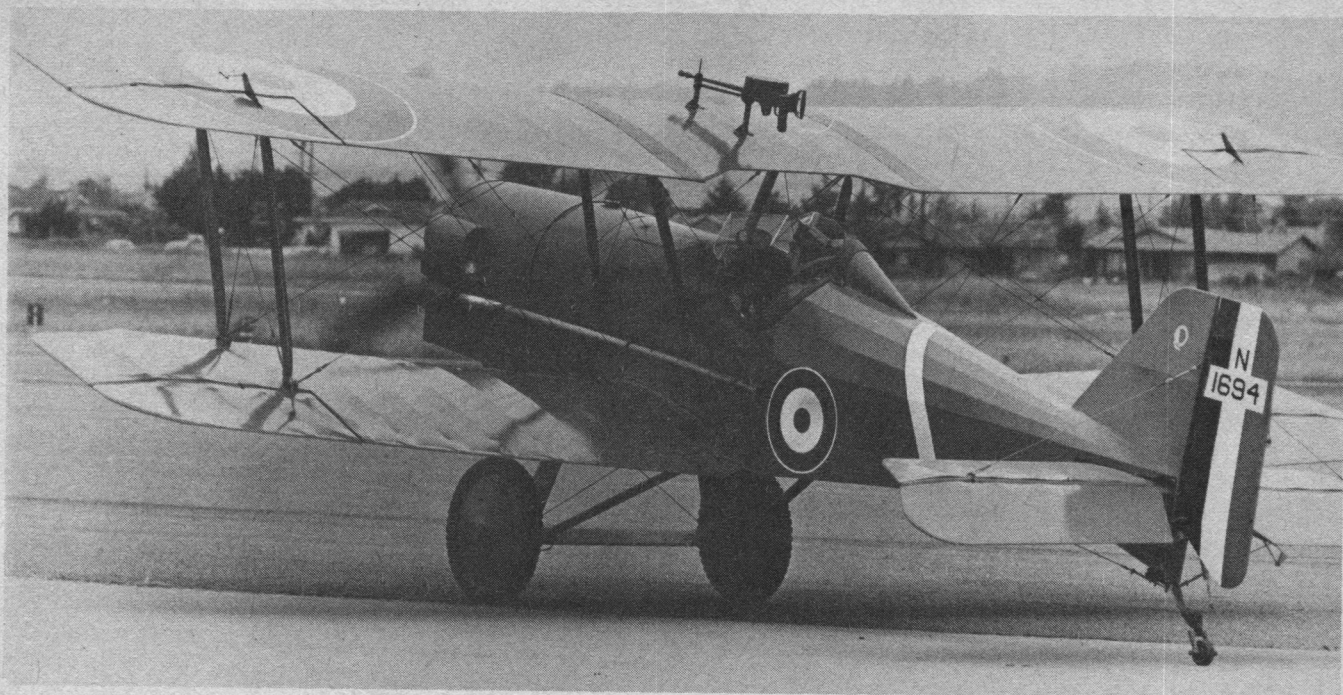
As in aerobatic or spin testing, flight-flutter testing should be done at the highest feasible altitude, says John W. Thorp, designer of the Thorp T-18. Thorp recommends testing one set of control surfaces at a time up to V_d — a speed 10 percent greater than the maximum indicated airspeed at which the aircraft need ever be flown. (This speed is called V_{ne} and is marked as the ship's "red line" velocity.)

Approach the V_d flutter test speeds incrementally, not all at once, and remember that while the aircraft may not flutter at 110 percent of V_{ne} at sea level, it may flutter at altitude at the same indicated airspeed, for flutter susceptibility is a function of true airspeed.

To start out, run flutter tests in level flight at normal cruise power, trimming the ship to fly hands off and then



Flight-testing a water bird can be fun, but make sure your wheels are up before putting the Spencer Amphibian back down!



You never know just how a homebuilt will fly until you're airborne, because you won't have wind-tunnel data to lean on.

slap the stick (or wheel) back sharply, in the aft direction. Repeat the test over and over until you reach a speed 10 percent over the red line speed (V_{ne}), making at least three attempts at each speed.

Next, begin the aileron flutter tests at cruising speed, first pulling the stick back slightly before batting it sideways, to produce a deceleration that will reduce the danger of including a divergent flutter condition. Aileron displacement of more than three degrees is not necessary.

By approaching the V_d speed gradually, you will be able to ascertain any incipient flutter condition that may develop — evidence, Thorp says, “that you have tickled the dragon’s tail.” Corrective design steps may then be taken before proceeding with the flight-flutter tests.

Lastly, test the rudder for flutter in the same way as the other control surfaces, pulling the stick back a little before booting the rudder to induce deceleration. To check each surface at V_d with a transient speed, it will be necessary, of course, to initiate the checks at slightly above V_d .

Flutter is apt to be destructive, hence the homebuilder must demonstrate through flight-testing that his bird won’t flutter within prescribed airspeed limits. Ken Rand redlined his pretty little KR-1 at 135 knots to remain below an aileron flutter tendency at higher speeds.

A simpler, and often more tedious, flight-test chore is airspeed calibration, which involves flying over a measured distance through the normal speed range, in opposite directions to eliminate wind effect.

Colonel Dale Anderson (USAF, Ret.), co-developer of the splendid new Spencer Amphibian Air Car with designer P.H. Spencer, checks his airspeed to critical values by flying over a carefully-measured mile course along the Long Beach, Calif., outer breakwater.

You can do the same between two VORs, for example, if

you know the exact distance in either statute or nautical miles. In using statute miles, Col. Anderson computed one cruise power setting airspeed by flying the 19.7 statute miles between Van Nuys and Los Angeles VORs, in both directions, timing each run with a stop watch. The southward run took 575 seconds, the northward run 484 seconds. The average speed was computed at 134.935 mph, using the formula:

$$\frac{5280 \text{ (feet)} \times 19.7 \times 3600 \text{ (seconds)}}{5280 \times 575} = 123.34 \text{ mph (south)}$$

and

$$\frac{5280 \text{ (feet)} \times 19.7 \times 3600 \text{ (seconds)}}{5280 \times 484} = 146.53 \text{ mph (north)}$$

The test flight, of course, isn’t finished until after the landing and rollout, and the taxi back to the barn for congratulations or consolations. Prior to landing, run through a series of stalls at altitude to determine best approach and stall speeds, with and without engine power. Any tendency of the aircraft to roll-off or otherwise behave erratically can be pinpointed, allowing you to cross the fence courageously with a few extra mph for grandma, but not enough to burn up the whole runway.

I’ve talked to Pitts Special pilots who tell me they like to fan the rudder on takeoff or landing, but this is anticipating trouble before it happens. Personally, I prefer cautious rudder action, allowing the aircraft to find its own pace, and then responding accordingly, but that’s getting back into the area of hangar-flying arguments.

There’s plenty of that whenever test pilots get together, and in fact it’s a good time to listen. You never know when you’ll pick up a tip to improve your own flying!



It's A Coot



FOR ALL-OUT recreational flexibility it is hard, if not impossible, to beat an amphibian. It can go anywhere a land-plane can go, and a host of other fun spots as well.

One of the most interesting homebuilt amphibian designs is the Coot, and plans are available in two versions from Molt Taylor, P.O. Box 1171, Longview Wash. 98632.

Growing out of design experience developing Marine Corps amphibious assault gliders during World War II, the Coot makes use of "waterline" inboard wing sections to provide stability on the water, omitting outboard floats which Taylor says add weight, drag and extra construction time.

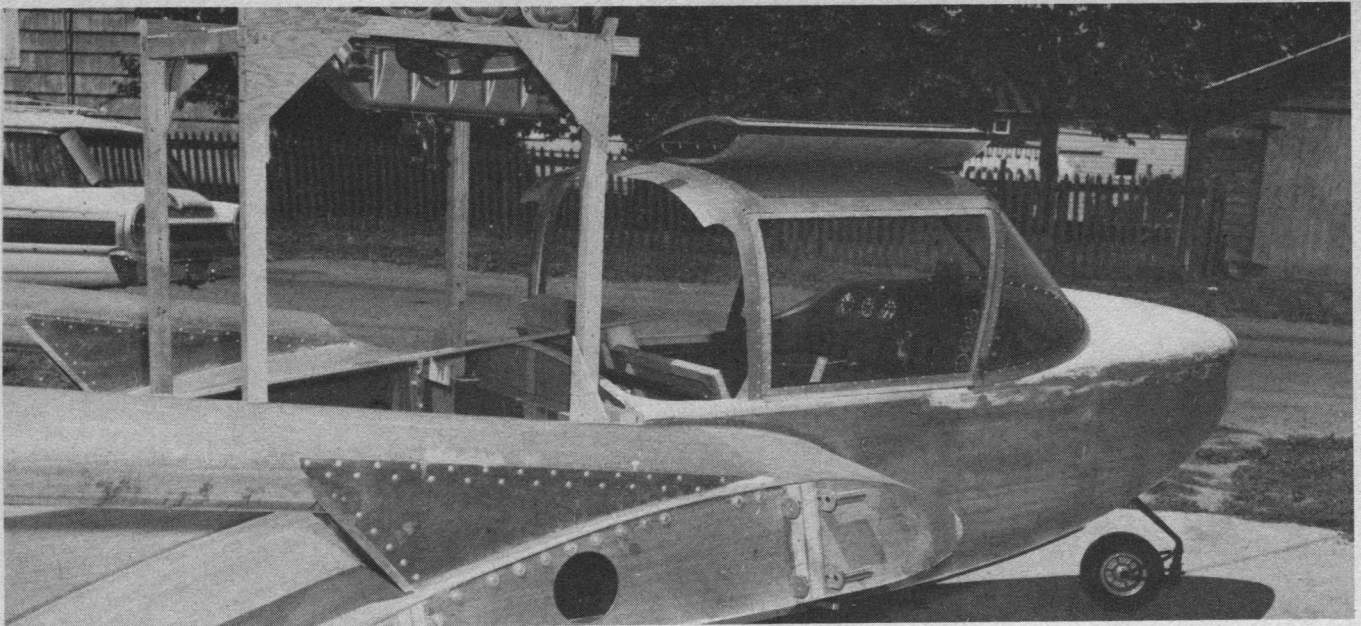
The first Coot B to fly was a twin-boom version built from Taylor plans by Dick Liljegren of Kelso, Wash. The prototype Coot A single-tail version was built as a pure seaplane (sans landing gear) but two retractable gear versions of the

A are now under construction. Both airplanes feature folding wings and can be towed on a boat trailer for home storage.

Construction is primarily marine mahogany plywood and aircraft spruce, stapled and glued. The wood wing uses spars, diagonal ribs to eliminate internal wire bracing, and fiberglass covering on the leading edge. The balance of the wing cover is synthetic fabric. The main spar passes through the fuselage aft of the two seats.

The tail boom and surfaces on the twin-boom version are of all-metal construction, but the single-tail model can be either all metal, steel tube and fabric or sheet metal boom with fabric covered surfaces.

Engine power can range from 100 to 150 hp on either model. Liljegren's Coot cruises at 115 mph on a 125-hp Continental. On either model the engine mount can be steel tube or sheet metal, but considering the engine location the



Construction picture of Coot-B prior to installation of 125-hp powerplant.

strongest possible engine mounting should be chosen.

A 25-turn manual cranking system is provided to retract the landing gear, with the castoring nose wheel moving up and forward and the main wheels swinging aft. Main gear legs are of leaf spring steel, and retract into sealed wing wells without doors. Provision can be made for power gear retraction.

Entry into the cockpit is through the canopy, which folds up on each side and can be removed entirely for open-cockpit flight. Seats are hinged to lift up like theater seats so occupants can stand up and have a wide floor area to fish. This bird is designed for fun, camping, swimming, etc., so there is no problem about coming aboard dripping wet and covered with sand. The floorboards come up and the interior can be hosed out with water, which drains out at the step.

Taylor advises that in addition to the normal plywood hull, he is offering a fiberglass hull shell into which homebuilders can fit their own frames and complete construction.

A set of 100 professional-quality 4-by-5 inch construction

photos is offered for \$25, and the detailed construction plans containing more than 250 sheets sell for \$150. •

Taylor Coot A or B

Wing span: 37'

Length: 22'

Height: 8'

Width, folded: 8'

Tail span: 8'

Wing chord: 5'

Wing area: 180 sq.ft.

Empty weight: 1,000 to 1,200 lbs.

Gross weight: 1,800 lbs.

Fuel: 24-30 gal.

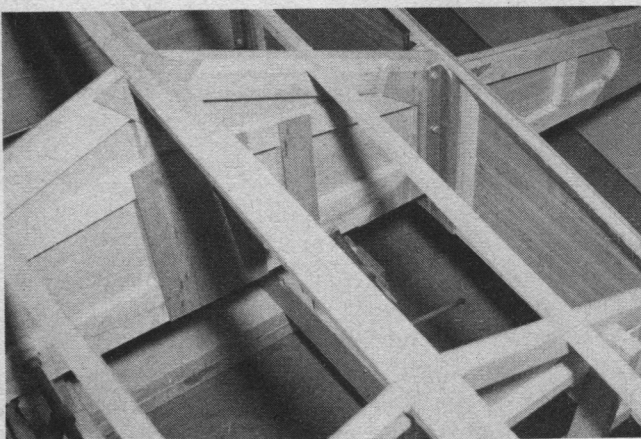
Power: 100-150 hp

Cruise speed: 100-120 mph

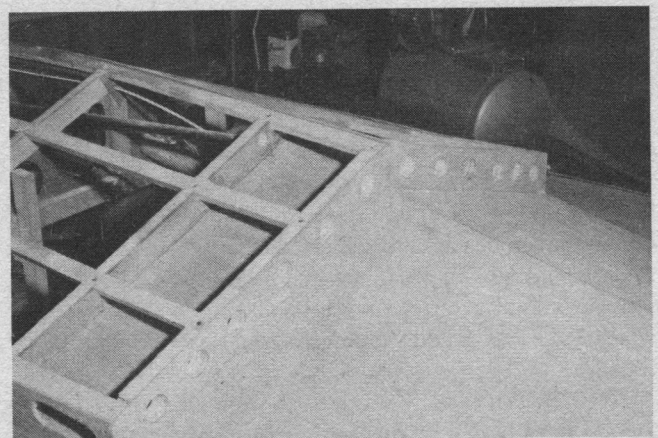
Climb rate: 600-800 fpm

Construction: Basically wood

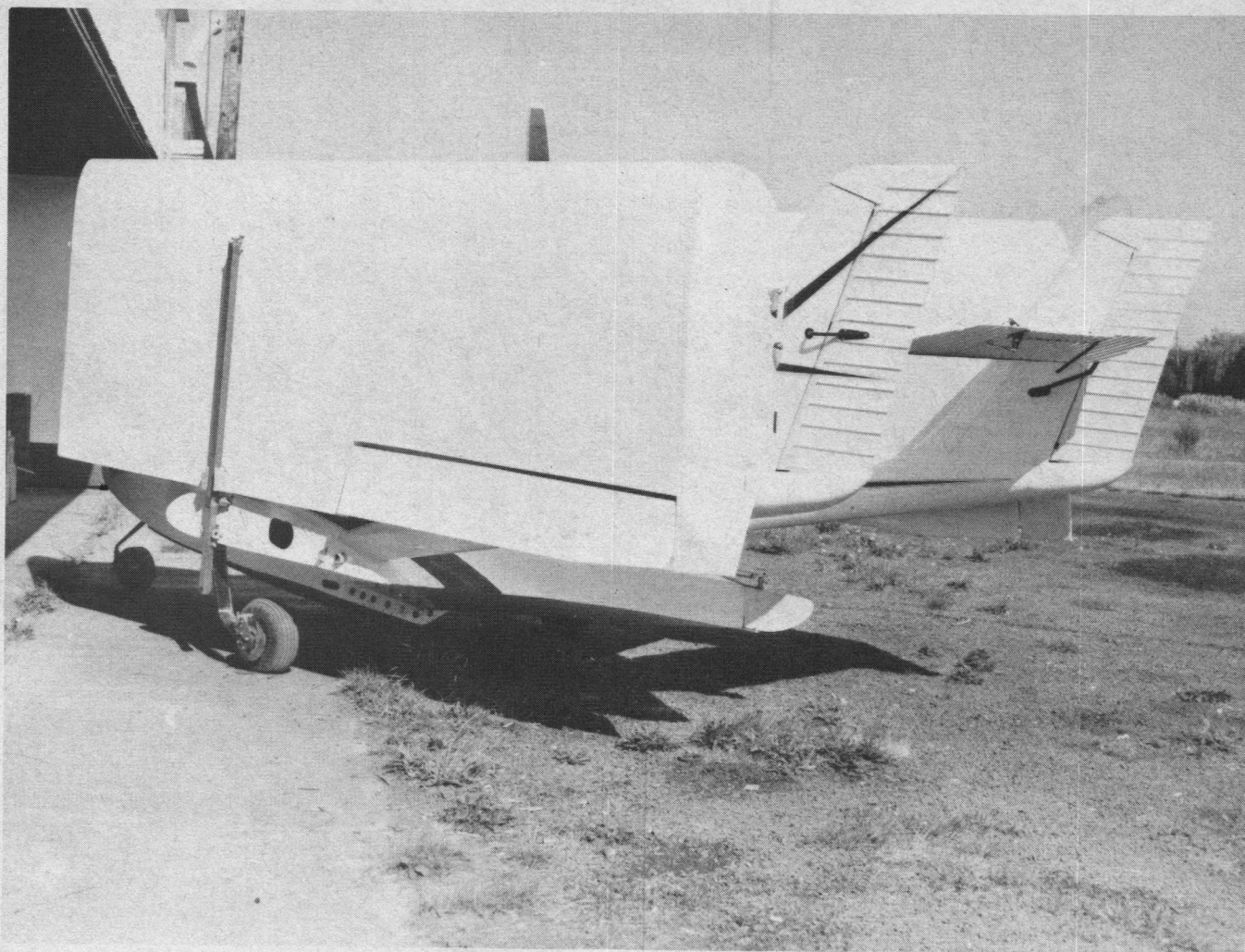
Airfoil: NACA 4415



Typical wood structure at rear spar carrythrough of Coot-B amphibian.



Typical hull construction showing step vents before covering forebody bottom.



You can fold back the wings of the Coot-B for trailing home and storage in garage.



Coot-A planes nicely on step during takeoff run across glassy water of vacation lake.



A New Breed Of Biplanes

A NEW BREED of airplanes is becoming more and more numerous — the small single-seat biplanes of the non-production type, licensed in the experimental category. Sometimes they are raced. Sometimes not.

One of the finest of these — the winner very often in its class for workmanship — is the ship built and flown by James Janson, of Pacoima, Calif.

How small these biplanes really are can be best understood by comparison. Janson's ship is 16 feet long and has a wing span of 17 feet. For comparison, the well known Boeing Stearman army and navy primary trainer biplane has a span of nearly 33 feet and a length of about 26 feet. Almost twice the size.

Janson, who unaccountably is called "Don," built his ship solo in a backyard garage from scratch using only a set of \$25 blueprints as a guide. There's a lot more to his story, of course, but it probably is a fairly typical one. The only major difference is that not all builders may equal his ability to turn out a job so superior in craftsmanship.

Indeed, as so often is the case, there is more to the story of his biplane than meets the eye. It is another instance of the intrepid airman. For Don Janson turns out to be not just the builder of a backyard airplane but also a bold hero, and undaunted adventurer of no small portions.

What would you say of a man with 125 hours in his logbook who had just finished a handbuilt aircraft. And who had been so preoccupied that in the preceeding year had logged only five of those 125 hours. And who thereupon climbed into his newly completed ship and took off. That calls for a substantial dose of personal courage. More so when the flight was not an impulse of the moment but a long-planned calculated risk.

With Janson, however, such risks were not without precedent. You may recall the famous endurance flight of the Sunkist Lady in 1949. More than 1,000 hours aloft in a light plane for what amounted to some six weeks of uninterrupted round-the-clock day and night flight. The pilots were Dick Riedel and Bill Barris. And, as part of their record setting, they flew cross-country from Fullerton, Calif., to Miami, Fla., refueling along the way. Newspapers were filled with photos of the team gassing the ship along the way from cans handed to them by a man standing in the rear of a speeding jeep.

Don Janson was the man standing on the rear of the jeep

handing up the gasoline to Barris and Riedel.

Despite such adventurous doings, however, Janson had a deep desire to build and fly his own ship. When this urge came on, he doesn't know. His flying career goes back to 1930 when as a youngster he barnstormed the Illinois and Indiana area with Harold Johnson in a Ford Tri-Motor.

Janson took his first step in a determined effort to get his private pilot ticket just before World War II. He had 35 hours and was about to take his exam when, on the morning of December 7, 1941, he was stopped while taxiing onto the runway.

Eventually he persisted, however, and he had his private pilot license. Late in the 1950s he spotted a small biplane design of the late Frank Smith, a Douglas Aircraft engineer. By 1959 Janson decided to make his move. For \$25 he bought a set of Smith Miniplane blueprints from Mrs. Dorothy Smith, at 1938 North Jacaranda, Fullerton, Calif.

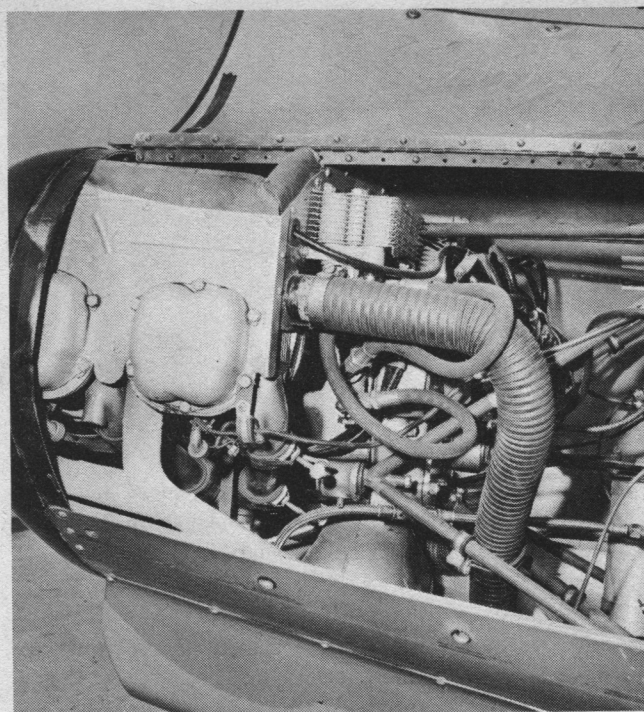
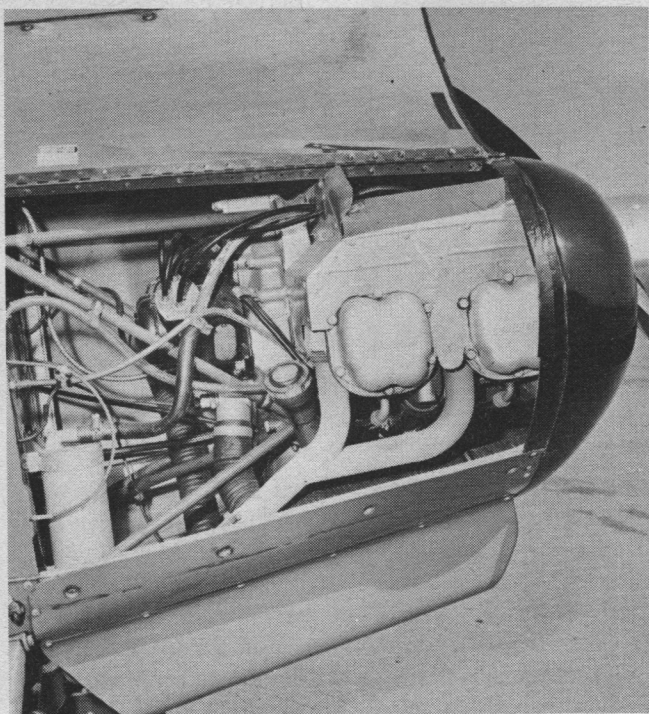
As of now, there are more Smith Miniplanes flying than any other small biplane design. The latest FAA census of aircraft lists 93 built, of which 50 are active and 43 inactive. Such ships are built only from blueprints. There are no kits, since such kit airplanes are not legal in the United States.

Janson began construction in February, 1959, in a small two-car garage near the intersection of Wilshire Boulevard and Western Avenue in the congested apartment district of urban Los Angeles. The presence of an aircraft in such an unlikely location drew considerable attention.

There were no major problems in construction. Janson is not an A&P. But he found the meetings of the Experimental Aviation Association his major source of information. Parts chasing took much of his time. Basically, the fuselage is chrome moly tubing, wings are spruce and fabric is Ceconite. Engine is an 85-hp Continental, from a scrapped J-3 Cub, which also provided the instruments. Janson said the FAA was very cooperative on the project.

Although construction spanned four years, there was a two-year period when the ship sat untouched in the garage. It was finished in February, 1963.

Some interesting modifications were made to the original blueprint by Janson. Empennage was extended 15½ inches and the front engine mounts were then moved forward for balance. Janson also added his own rudder trim linkage and improved the aileron controls. Elsewhere the design was unchanged.



Views of the original four-cylinder from both sides. This 85-hp Continental was replaced by a more powerful Lycoming engine. The mounts were also moved forward.

So the ship was completed. The length and wing span were the previously mentioned 17 and 16 feet, respectively. Overall height is five feet seven inches. Gross weight is 950 pounds, while the ship can lift a useful load of about 300 pounds. The four-cylinder engine is fed by carburetors at the rate of about $5\frac{1}{2}$ gallons per hour from a 16-gallon tank. Propeller is fixed pitch. Oil capacity is $4\frac{1}{2}$ quarts.

The biplane was loaded onto a car trailer, the wings tucked in alongside and Janson hauled his creation to the picturesque Rancho Conejo Airport (pronounced co-nay-ho), about 50 miles northwest of central Los Angeles, surrounded by the Santa Susana mountain range. Conejo (666 L H 42 U) was closed later to make way for a housing tract.

There the ship was finally assembled. Claude Grey, a Western Airlines captain, who had previously built a similar biplane in partnership with WA Captain Bob Conover, took Janson's prize up for its first test hop. All went well except for some engine cooling problems. Janson spent the next month on the ground in a small hangar alongside the runway doing a fix. Then early one March morning, before the mountain air acquired its usual turbulence, Janson climbed into the cockpit and pulled on his helmet and goggles. The dreams of more than 30 years were with him.

Janson had plenty of beforehand advice from pilots who had never flown such a ship. It'll be really touchy, they said, and quick as a cat. You'll have to think ahead of it. They were right.

So the 125-hour pilot tried a bit of taxiing to get the feel. It didn't work too well. "It's better just to take the ship and fly it off," says Janson now. So on that first flight he sneaked down the runway and wobbled into the pattern. Rancho Conejo was not the easiest airport in the world for first

flights of any kind. Mountain ridges come up fast. But Janson rode around and down. After that it was just practice. Initially, Janson wore a chute at all times. But as his confidence grew, he began to leave it behind. Now he wears one only for aerobatics or closed course racing. Yes, just 500 hours later, Janson was racing his ship.

With its 85-hp engine, the ship cruises at 105 mph and has a top of 125 mph. Ceiling is 14,000 feet and the rate of climb is 900 fpm. Takeoff run is 400 feet and landing roll is 400 feet. Range at maximum economy settings is about 300 miles.

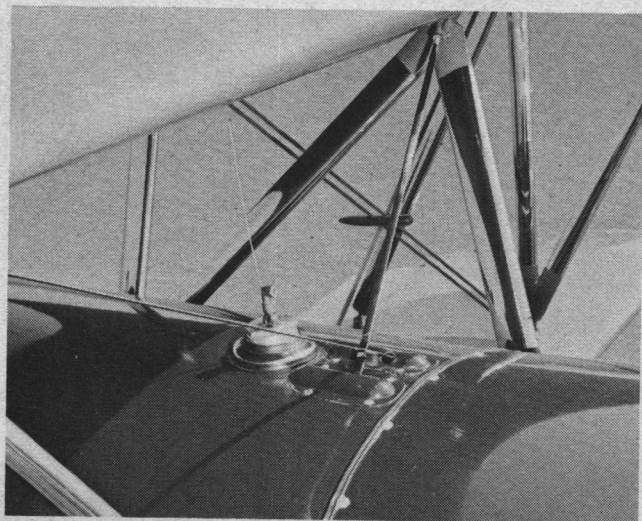
Janson plans to replace the Continental with a surplus 125-hp Lycoming that was manufactured during World War II for use as a stationary generator plant. These engines are plentiful and cheap. Prices are \$200-to-\$250. Naturally, they need overhauling and reworking. But they are basically aircraft engines. Second mags and carbs are needed, plus other items need converting. This horsepower rating was recently agreed upon as the limit for small biplane racing.

The pilot-builder-owner is very pleased with the handling characteristics of his ship. When it stalls at 65 IAS, it displays no bad habits. It does not wind into a spin or spiral — instead it just settles. When kicked into a spin, however, it winds up fast, but neutralizing the rudder brings the spin to a screeching halt. Nor is the ship a handful in a crosswind landing, since it actually is rather heavy for its wing area. About 100 square feet has a loading of about nine pounds per square foot.

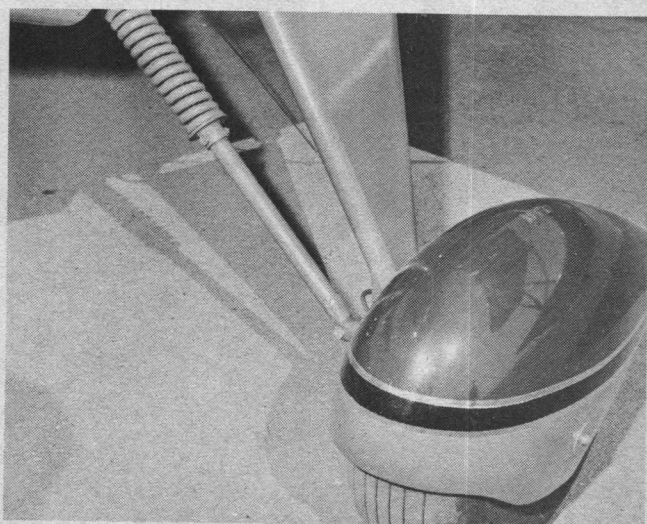
There is no radio yet in the biplane, but Janson plans to install a simple transceiver for working with control towers. The radio setup will be limited to communication only. He sees no need for radio navigation, such as omni. This is not a craft for long cross-country work.



Clean workmanship of cockpit area is one reason why Janson has won many trophies at EAA national fly-ins.



Fuel tank is just forward of pilot seat under top wing with float gauge.



Janson added spring shock absorber to landing gear for better landings.



Low-Cost Fly Baby

BACK BEFORE MODEL airplane kits came as bits and pieces of pre-cut plastic, they were built with balsa wood sticks glued together and covered with tissue paper on thin balsa sheets. And, in 1960, a Seattle pilot named Peter Bowers, thinking that was still a good way to build an airplane, scaled up the idea and produced a low-wing monoplane call **Fly Baby**. Pete figured the single-seat sports plane could be built for under \$1,000, and that — plus its simple straightforward looks — have made it one of the most popular and significant homebuilt airplanes on the market today.

Now it has a new look: Fly Baby has become Bi-Baby, a biplane. Nor is that surprising. Pete, like most homebuilt designers, had been fiddling with the basic design all along; he had it flying on floats at one time, for example. It's really to be expected — when a man builds a man-sized model airplane it should be easy for him to make changes and modifications as the mood strikes him.

A completely new set of wings was built to make the biplane transformation; the mere addition of a second wing on top wouldn't have worked. The new wings have a 22-foot span and a 42-inch chord, compared to 28 feet and 54 inches respectively for the original single wing, and area increases from 120 to 150 square feet with a mere 46-pound weight increase. Gross wing loading, thus, drops from 7.7 to 6.5 pounds per square foot, Pete figures.

The pilot sat right over the center of the wing in the earlier monoplane version, directly at the center of gravity. But an upper wing had to be located ahead of the cockpit to enable the pilot to get in and out. It was necessary, therefore, to give both wings a sweep back to bring their combined centers of lift into line with the original center of gravity. The sweep, together with such design factors as the gap-chord ratio, differing dihedral angles on the two wings, and wingtip shape, give Bi-Baby a decided resemblance to a scaled-down Tiger Moth from some angles. And that, Pete suggests, is no coincidence.

The switch to the biplane mode required no drastic alterations. The lower wings still use the same attach points and pins as the monoplane. The upper center section is attached to the monoplane landing wire fittings and at the upper engine mount support bolts. Both sets of wings are interchangeable and the switchover takes about an hour for two people to make.

Two wings, of course, have more mass and drag than one and Bi-Baby demonstrates it in contrast to Fly Baby's monoplane performance. With its 65-hp Continental engine, cruise speed slows by about 10 mph to 83-to-85 mph. Glide is steeper and rate of climb decreases somewhat, although the overall handling characteristics remain very similar to those of the single-wing configuration. Roll rate is the same, though Pete reports the biplane tends to float considerably more on landing.

While there is no real difference in aerobatic capability, Bowers observes that the biplane version seems to be better from a psychological standpoint. "Pilots just expect little biplanes to be more aerobatic than equivalent monoplanes," he explains. The 65-hp available leaves Fly/Bi-Baby underpowered for good airshow aerobatics, he admits, but the ship still does all the fun-type maneuvers well, such as loops, slow rolls and barrel rolls, spins and snap rolls.

When originally designed, Fly Baby was meant to be an easy-to-build, easy-to-fly, low-cost folding-wing airplane capable of being towed or trailered from the airport to the home garage for storage. It is built almost entirely of wood and covered with Dacron fabric. Construction methods are simple; no jiggling or special tooling is needed, and the use of welded metal parts is at an absolute minimum. Practically anyone who can get good grades in a high school wood-working class, Pete says, can build Fly Baby.

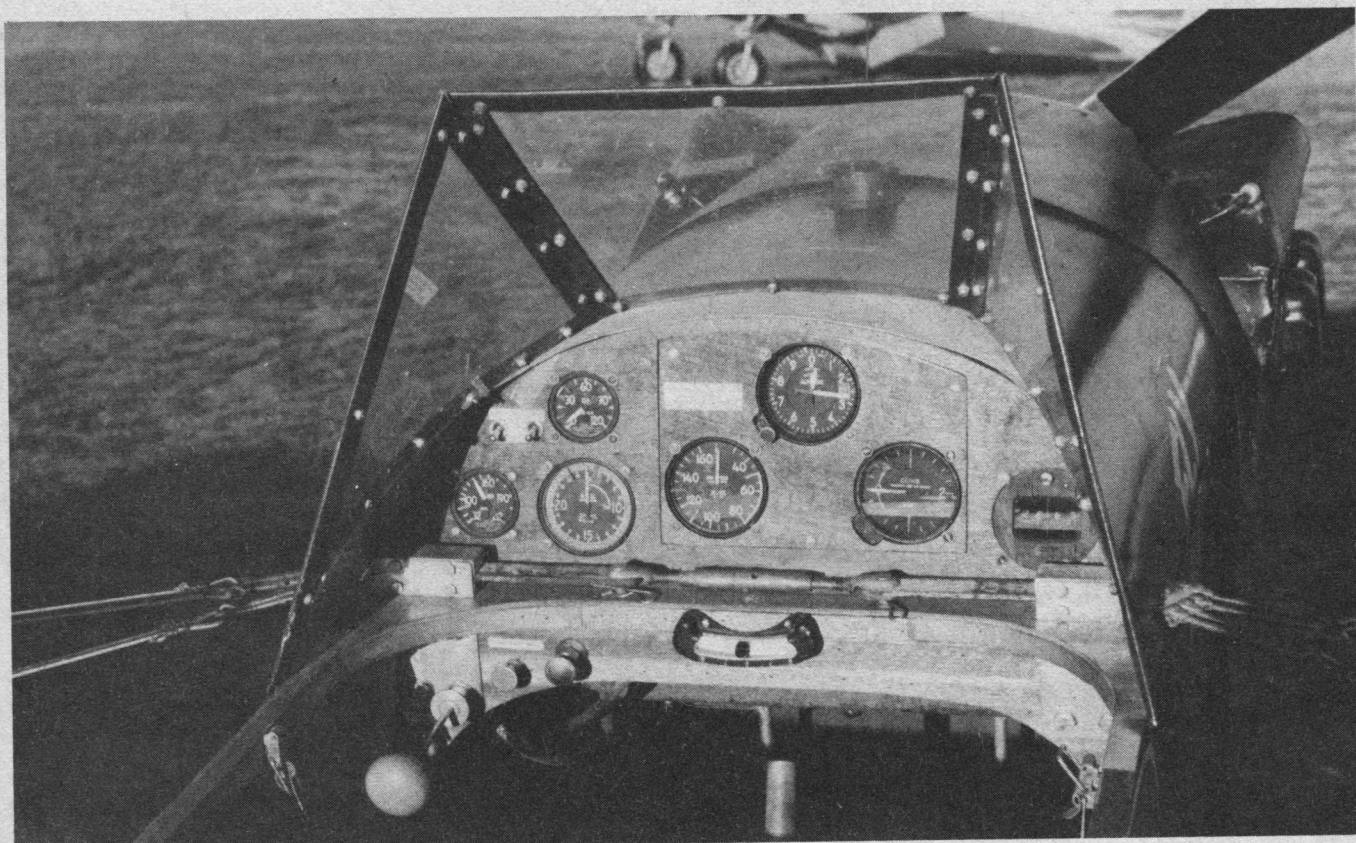
Bowers also designed the plane to have the most docile flying manners possible in a homebuilt airplane. Low takeoff and landing speeds and the climb performance for operating from small unimproved fields has been emphasized over the high speed end of the envelope. It can be flown for lengthy periods hands off, because of its stability, and is well within the capabilities of even student pilots who have had some time in conventional gear airplanes.

In developing the design, Bowers emphasized simplicity. Power should be between 65 and 85 hp; more power, while it could be used, usually means more disadvantages rather than advantages. Homebuilts usually are licensed for day-light VFR only, so no electrical system is needed — recommended. Bowers compares the plane to a small sailboat rather than to a piece of deluxe transportation, and as an item of outdoor sporting equipment he feels it should be sporting — hand propping and all.

Unlike many homebuilts, the design isn't all that tight



Fly Baby on floats converts the basic land monoplane into a water lover in which you can go explore back country lakes where the fishing is fine. Large wing makes float conversion possible.



Neatly paneled instrument board of the Fly Baby is an indication of the kind of workmanship that goes into this ship. Center part of panel is removable for easy access to gauges for maintenance.

fitting, either. Since all six feet, 1.5 inches of the designer himself had to sit inside comfortably, the cockpit is relatively roomy. There is room for radio and extra equipment, but an external baggage locker is slung between the landing gear. The gear itself is basic simplicity, relying upon the large 8.00 x 4 tires to provide shock absorbing action on rough fields.

Powers estimated it took 720 man-hours to build the prototype Fly Baby, but that is a variable which depends upon the time, skill and determination of the individual builder. Another variable — cost — amounted to \$1,050 for the first plane, at 1960 prices, of which \$375 was for new raw materials and \$675 went for used equipment including engine, prop, wheels, instruments and so on.

While construction plans had been published in the EAA magazine — Fly Baby was winner of the 1962 design contest — Bowers markets more detailed and complete plans keyed to step-by-step assembly drawings. These come in an 8.5 x 11 inch booklet, available for \$25 from Peter M. Bowers, 13826 Des Moines Way South, Seattle, Wash. 98168.

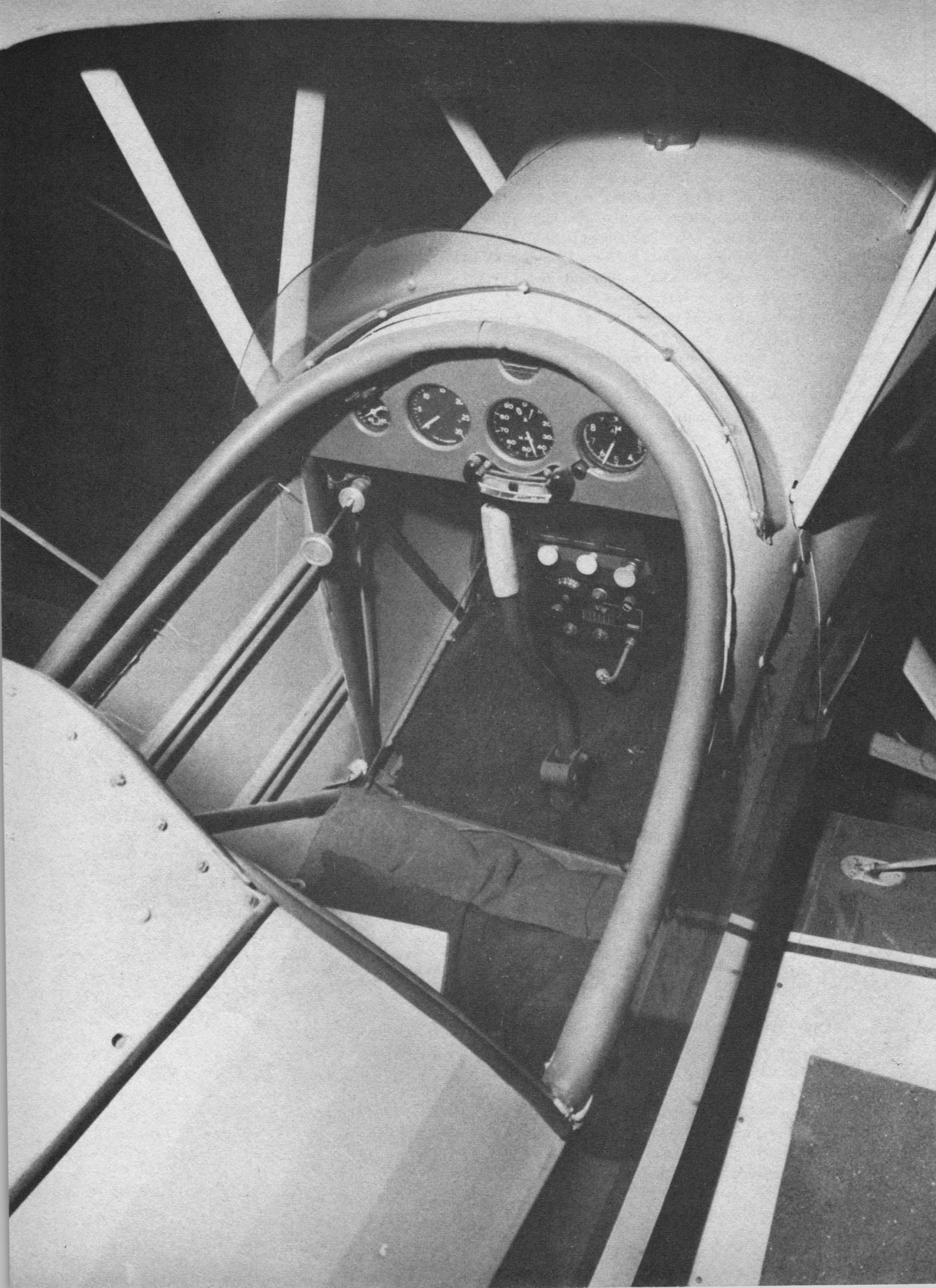
Drawings for the pontoon installation or the new biplane version are not yet part of the standard plans, but there is a special chapter on ground and flight testing. •

Fly Baby (Std.) Specifications

Wingspan, ft.: 28.0
Length, ft.: 18.9
Height, ft.: 6.9
Wing chord, in.: 54
Airfoil section: 4,412
Wing area, sq. ft.: 120
Gross weight, lb.: 925
Empty weight, lb.: 605
Useful load, lb.: 320
Engine, hp: 65-to-85
Fuel capacity, gal.: 12-to-16
Speed, cruise mph: 110-to-115
Rate of climb, fpm: 850-to-1,100
Construction: all wood



Pete Bowers' Bi-Baby biplane is a winner, whenever it appears at strange airports. The switch from one wing to two takes only about an hour with two people working. Built largely of wood and fab, Bi-Baby was completed in March, 1969, has logged many happy, carefree hours since.



The Smith Miniplane



ONE OF THE more popular itty-bitty bipes among the homebuilding fraternity is the Smith DSA-1 Miniplane, an airplane designed with the amateur homebuilder and pilot in mind. At last count, 158 copies of the saucy little ship had been built and launched by enthusiasts in the United States and Canada. The original prototype, built by the late Frank W. Smith of Fullerton, Calif., took to the skies in October, 1956, and the flock which has flown in its propwash provides a fitting memorial to the designer.

Performance and maneuverability are two of the prime attributes of the Miniplane endearing it to its builders. Originally designed to accept a 65 or 85-hp engine, most of the later models were produced with 125-hp Lycoming powerplants. Some use 100 hp and a few have even more powerful engines. Typical performance with the 125, however, shows a 130 mph top speed and 122 mph cruise, with a 1,600 fpm climb rate after a takeoff roll of 375 feet.

The Miniplane has a quick response, without any sloppiness in the controls, and it is stressed for aerobatics. It is not a tricky plane to fly but the pilot is advised to have some time in stick-controlled taildraggers logged before Miniplaning aloft — not so much because of any bad habits but because it is such a quickly responsive ship. Ground handling, on the other hand, is usually something to get used to and a good bit of taxi practice in the finished plane is

recommended.

Two false starts — sort of — and a friendly rivalry with designer Lou Stolp preceeded Frank Smith's development of his own brainchild. He always had liked biplanes, his widow Dorothy relates, and after a flying vacation into the midwest some years ago (where he saw a Stiab and a Rose Parakeet) he decided to have a small one. He located and purchased a Travel Air 12W basket case and, using its one good rib for a pattern, ultimately got it rebuilt and flying. But it was no small ship.

Later, he discovered his friend Lou Stolp building a Stits Playboy, which was small. Buying a set of plans immediately, Frank then made it two Playboys on their way to flying careers. His was finished and flying first, since Lou had had less spare time for building than Frank, but it still wasn't what he wanted. The Playboy was a monoplane.

During a hangar flying session one stormy night in the Smith garage (which never had had a car in it), Frank chalked the outlines of a small biplane on the floor. "This is what I want," he declared, and a Douglas design and stress engineer, Charles Radvilus, offered to help solve the engineering problems. Never one to waste time, Frank waded into the project and eight months later the first Miniplane DSA-1 (for "Damn Small Airplane"), N90P, was airborne. It was an instant success and requests for plans

came in. And as with the Playboys, the Miniplane had been built in a race with Stolp — this time against the latter's "Starduster."

A second ship, N99D, was started while Lee Wainscott concurrently began drawing up the blueprints. But Frank died of a heart attack before it was completed. Lee and other good friends finished it for Dorothy and their son, Donald. Don, now showing some of his father's plane building talents, presently is developing a two-seat "Miniplane Plus One" version.

Miniplanes are built of welded steel tubing for fuselage and tail group, with built-up cap strip ribs, spruce spars, and fabric covering. Costs obviously vary with builders, depending upon the extent of the job performed personally and their abilities to find bargain priced components. The engine, tubing, wheels, brakes and other building materials represent the largest outlay, estimated to be between \$1,500 and \$2,500.

Plans for this popular and perky performer are available for \$25 per set, including 33 plates of scale drawings and

isometric views and suggested materials lists. These can be secured from Dorothy Smith at 1938 Jacaranda Place, Fullerton, Calif. 92633. A rather detailed brochure describing the Miniplane to interested would-be builders is available for \$1.

Smith DSA-1 Miniplane Specifications

Wingspan, upper, ft.: 17.0

Wingspan, lower, ft.: 15.8

Length, ft.: 15.08

Wing area, sq. ft.: 100.0

Gross weight, lb.: 1,000

Empty weight, lb.: 616

Useful load, lb.: 384

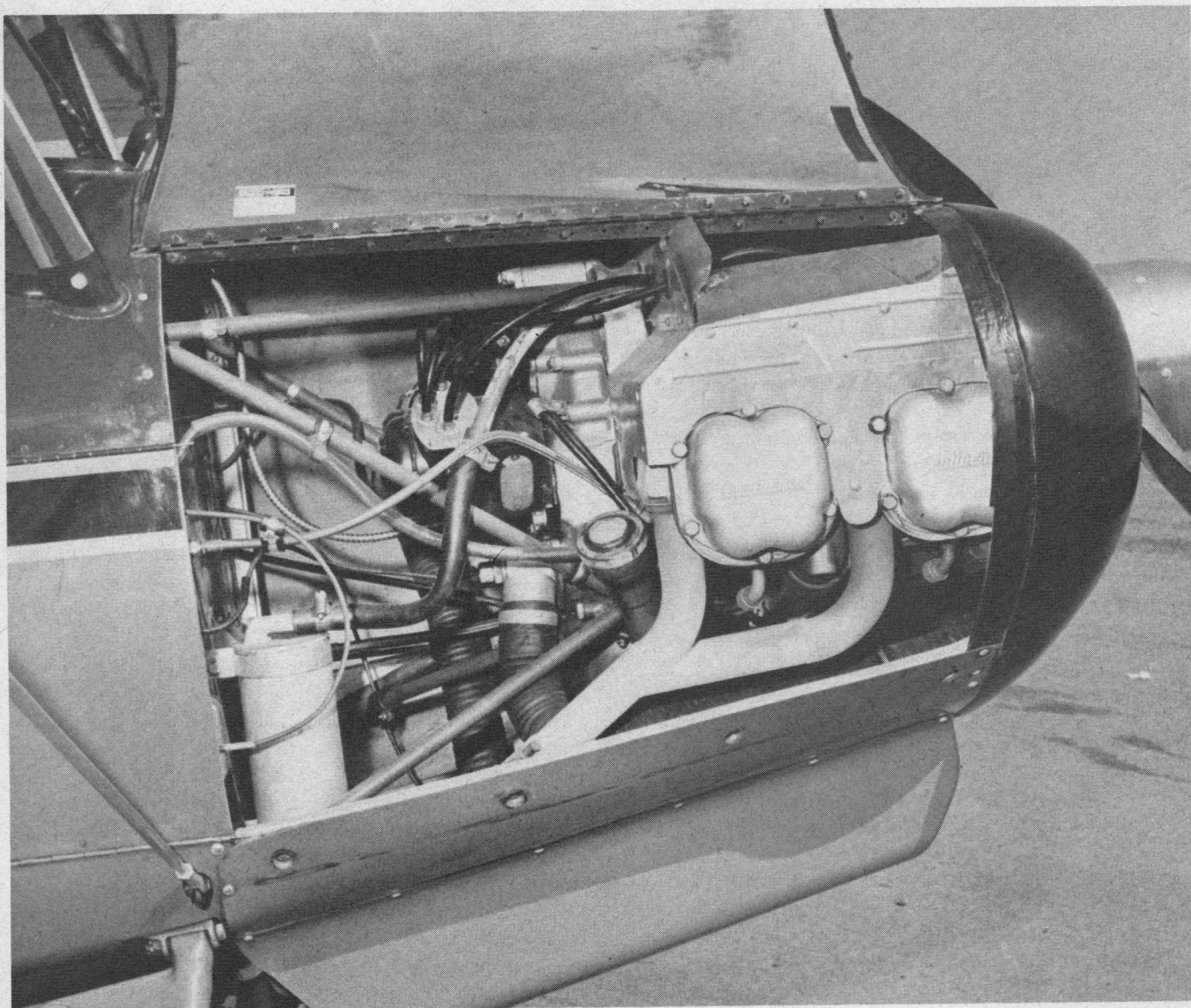
Engine, hp: 100

Fuel capacity, gal.: 17

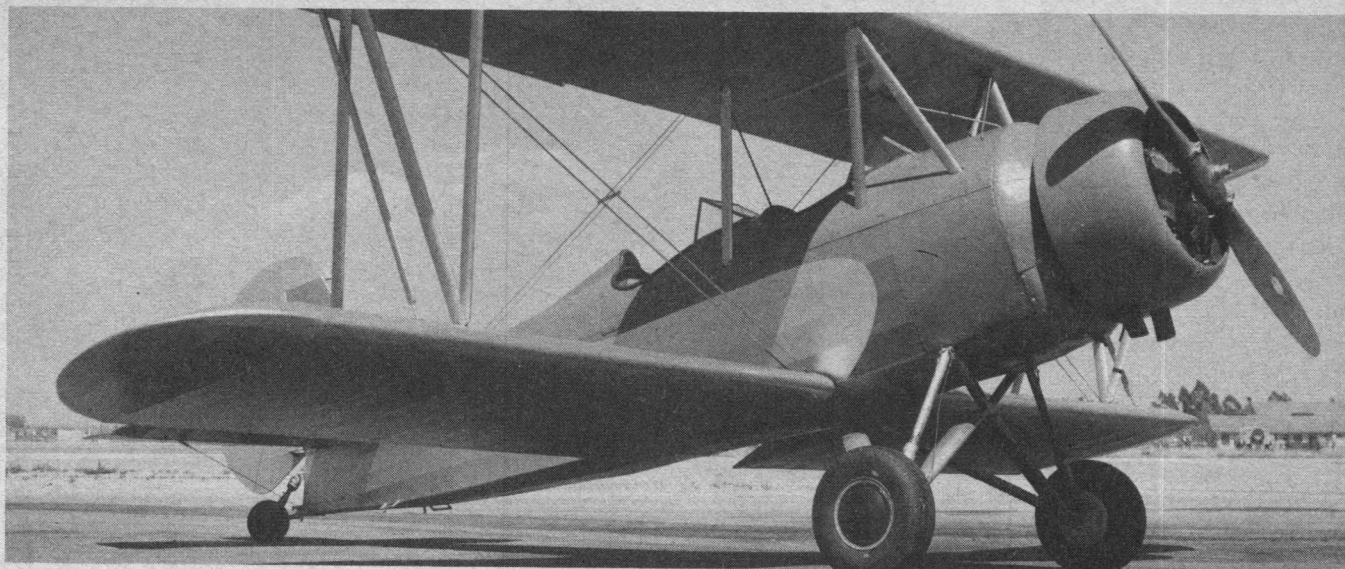
Speed, cruise mph: 117

Rate of climb, fpm: 1,250

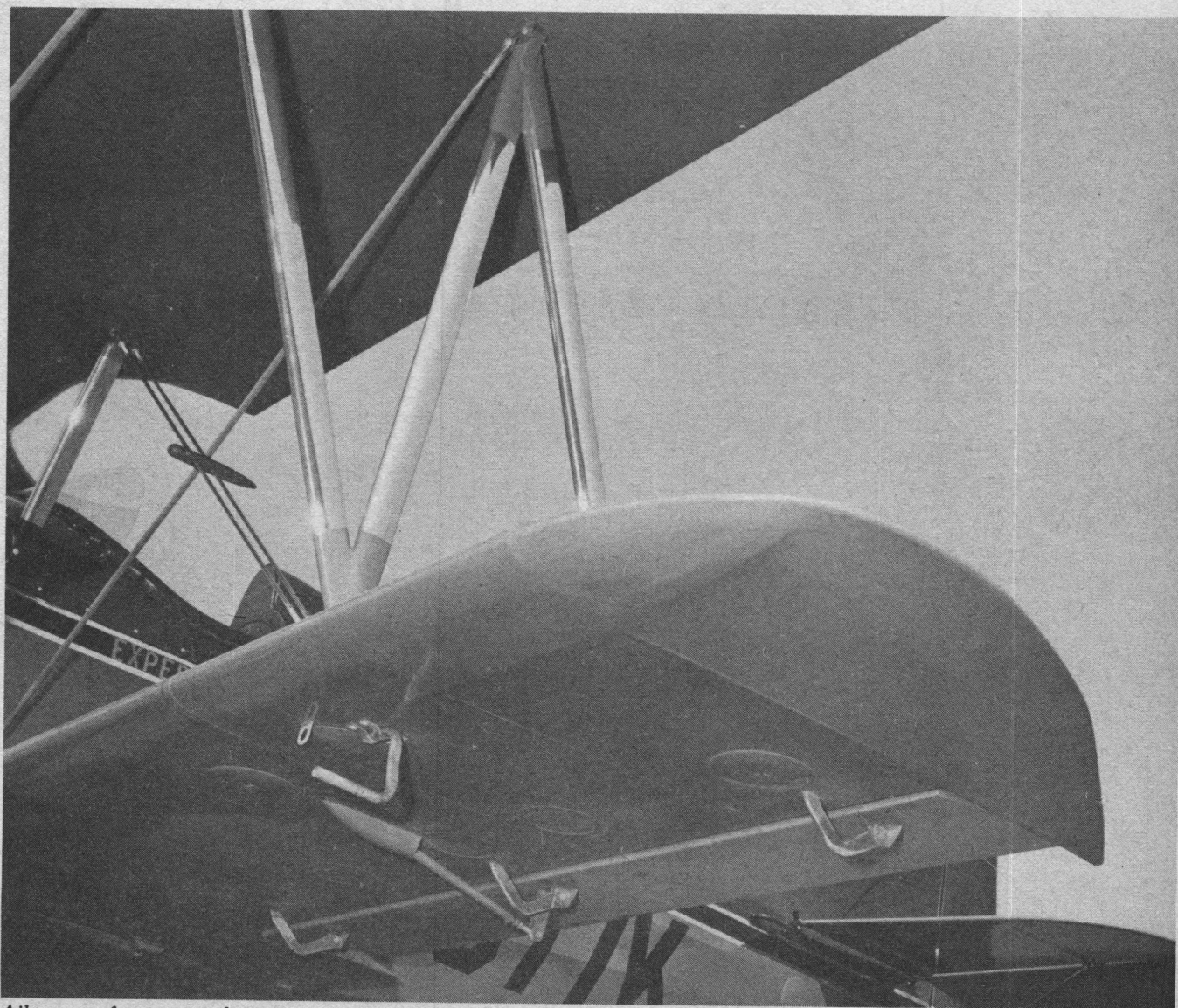
Construction: Steel tubing, wood, fabric cover



Continental engines of 65-85 horsepower in early Miniplanes have been uprated.



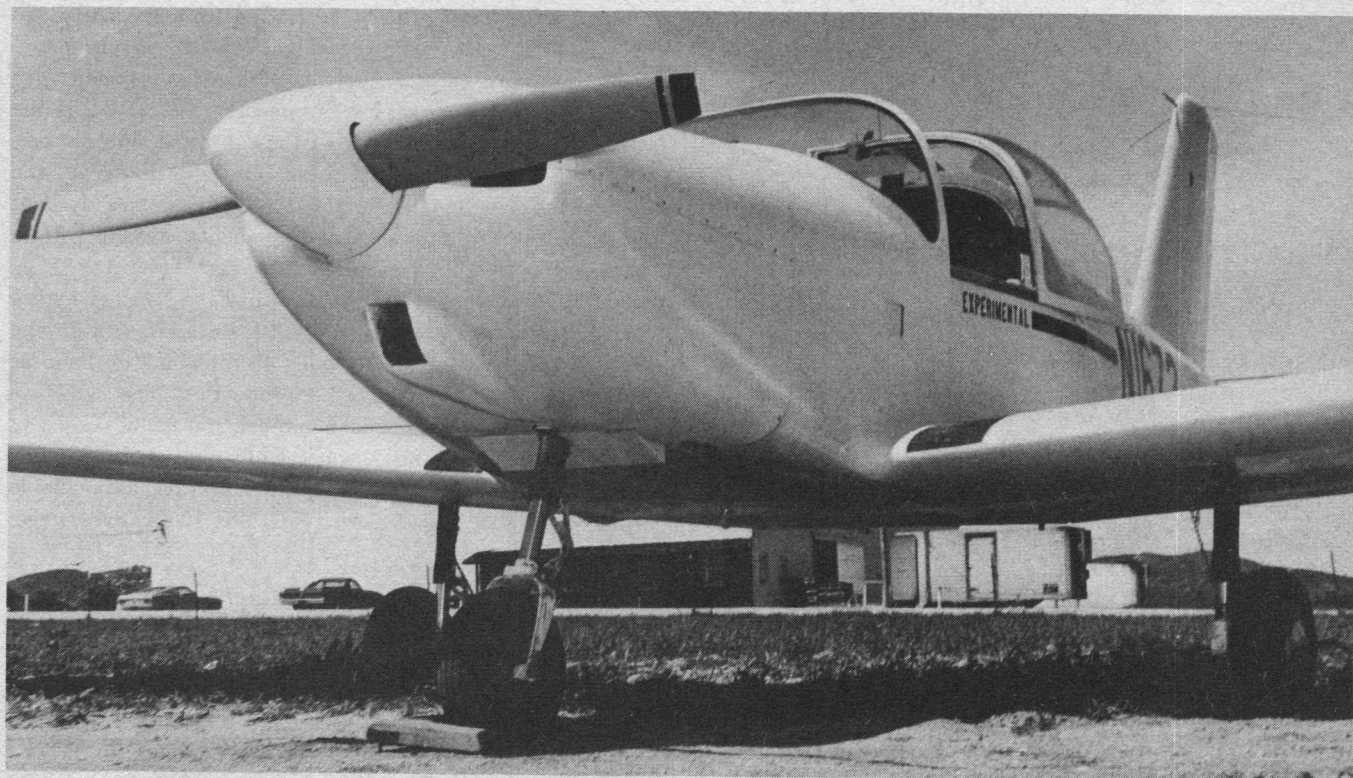
Frank Smith's first built-up plane was this Travel Air 12W, once a basket case.



Aileron surfaces are on lower wings only but provide highly adequate roll rate.



Pazmany PL-2



ONE OF THE MOST impressive two-place homebuilt airplanes currently flying is the all-metal Pazmany PL-2, a 28-foot span tricycle gear airplane that will climb at 1,500 feet per minute and top out at 144 mph using the familiar Lycoming O-290-G converted ground power unit.

A number of striking design features are incorporated in this airplane. For one thing, despite its aerodynamically clean lines, there are no compound curves anywhere in the PL-2 skin. Simple curves are used instead, making it easy for amateur builders while avoiding the oil-canning effect of flat skin panels.

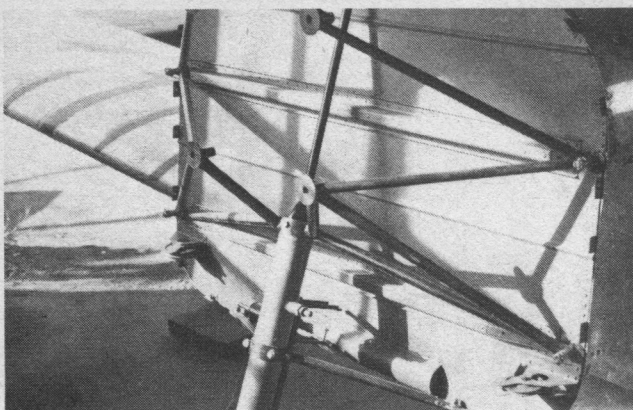
The wing is a single-spar laminar airfoil, built in one piece and with the landing gear attached directly to the spar. The seats, control sticks and flap lever are also built into the wing structure, which is then bolted to the fuselage. The tail group uses an all-flying horizontal tail with push-pull tube control, and a large vertical stabilizer with cable-operated

rudder.

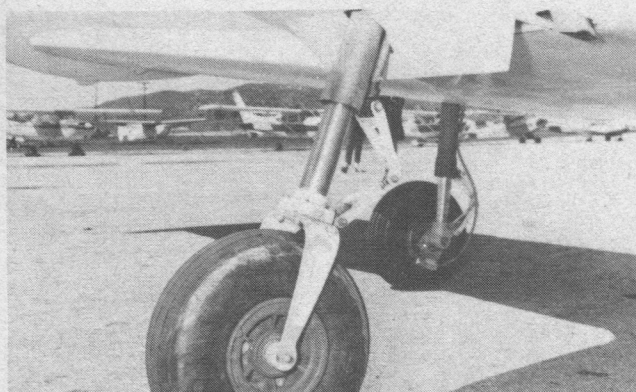
Engines from 108 to 150 hp can be mounted under a fiberglass cowl with sheet metal sides. Optimum performance is with the Lycoming O-290-D2B which offers a speed of 130 on economy cruise and 148 top, with rate of climb at 1,600 fpm and 3.8 hours or 493 miles range on economy cruise. With a 150-hp engine top speed rises five mph and rate of climb goes up 100 fpm, but there is a severe penalty in fuel economy and range.

The PL-2 carries its fuel in fiberglass wing tip tanks, and these are among many parts the designer will supply already fabricated. Machined aluminum spar caps, canopies and windshields, cowlings, fairings and landing gear parts can also be ordered.

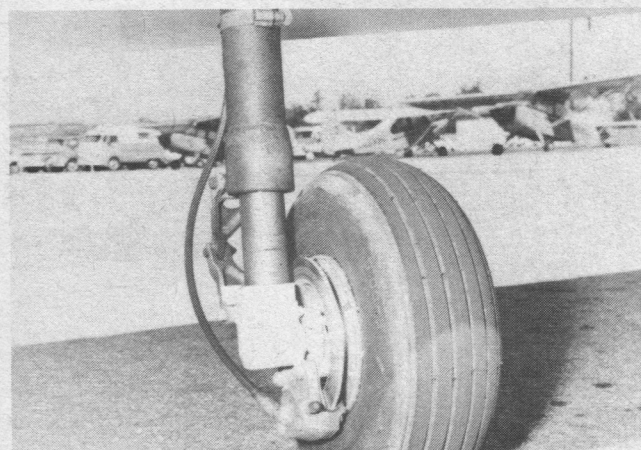
Stressed to plus 6 and minus 3 Gs, the aerobatic PL-2 is a refinement of the original Pazmany PL-1 which has accumulated more than 1,200 hours since 1962, much of it IFR. More



PL-2 firewall and engine mount, which also supports the steerable nose gear.



PL-2 nose gear has oleo-pneumatic shock absorber, and the unit is steerable.



The PL-2 mains also are oleo-pneumatic shock absorbing, have 5.00 X 5 tires.



Fuselage tail cone skins clecoed to frames, with simple curves that avoid oil-canning.

than 370 sets of plans for the PL-1 have been sold, and finished aircraft have been built from them in construction times ranging from 26 months to a mere 100 days. Right: 100 days. The Chinese Nationalist government couldn't afford to buy primary trainers for their air force, so they bought Pazmany plans and built their first PL-1 in that time. They liked it so well they are now building 35 more.

In-flight handling may be one reason they liked it. Pilots who have flown the PL-2 report it is quite responsive to the controls, with a high roll rate and sensitive pitch response — an airplane flown with the fingers and not the fist.

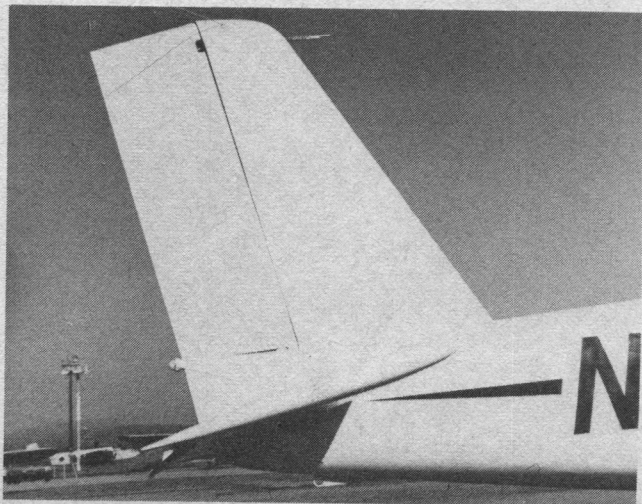
Great care was taken by the designer, Hungarian-born aeronautical engineer Ladislao Pazmany, to make the PL-2 even easier to build than the PL-1. Complex parts such as the cowlings and tip tanks may be formed of fiberglass by the builder, or ordered already fabricated from Pazmany. The balance of the structure is straightforward, simple metalwork that any careful home craftsman can handle. An example of the labor-saving designed into the PL-2 is the extruded spar cap. On the PL-1 the cap was a built-up unit requiring considerable fabrication time. For the PL-2, the designer is sole supplier for taper-milled caps already bent for dihedral. In addition to components available from Pazmany, other suppliers offer kits of certain hard-to-shape metal parts such as wing ribs and fuselage formers hydroformed to exact size. Plans for the PL-1 are \$75, and for the PL-2 \$150. The PL-2 set includes 48 drawings on linen or Mylar for stability and good reproduction. The drawings identify every part by a dash-number and include a list of materials with stock sizes, sources of supply and other key data. A \$3 brochure describing the PL-2 also is available from Pazmany Aircraft Corp., P.O. Box 10051, San Diego, Calif. 92110.



Comfortable side-by-side seating of PL-2 made this Pazmany design a good trainer.



Sliding canopy of PL-2 provides good visibility.



Balanced elevators provide good pitch response.

Pazmany PL-2

Wing span: 28.6'
 Wing area: 116 sq.ft.
 Length: 19'4"
 Height: 7.8
 Gross weight: 1,445 lbs.
 Empty weight: 900 lbs.
 Engine: Lycoming O-290-G
 Horsepower: 125 at 2,600
 Wing load: 12.13 lbs./sq.in.
 Power load: 11.56 lbs./hp
 Baggage capacity: 40 lbs.
 Fuel capacity: 25 gal.
 Top speed: 144 mph
 Economy cruise: 128 at 2,350 rpm
 Stall speed, flaps down: 54
 Rate of climb: 1,500 fpm
 Range, statute miles: 486



Stolp Starduster Too



THE MAGIC PROPERTIES of stardust have been part of the folklore that has charmed children all over the world for generations. Lovers know all about stardust, and Hoagy Carmichael knew all about lovers when he captured the magic in a timeless song.

Airplane builder Lou Stolp may or may not know all about lovers or children's fairy tales, but he certainly knows all about the magic of stardust, because he has refined the essence of it into one of the most popular sports biplanes of recent years, the sparkling Starduster Too.

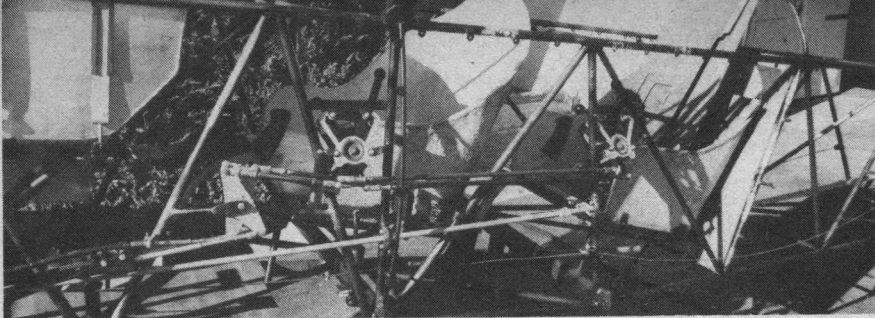
Everybody knows that stardust will cure whatever ails you, and upwards of 1,000 citizens have paid \$50 per set of plans so they can take regular doses of the tonic that comes from flying this graceful tandem two-seater.

The airplane has flown with engines ranging from 125 to 260 hp, though Stolp recommends the 180-hp Lycoming with a constant speed prop as the optimum powerplant. Construction cost seems to run from \$2,000 to \$2,500 depending on how careful the builder is in buying materials. Airline pilot

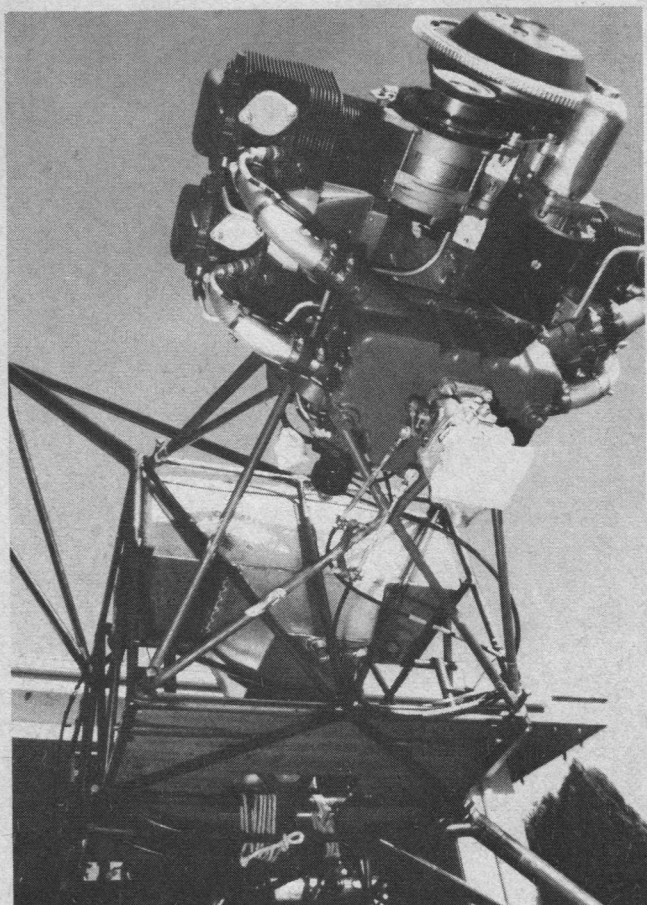
Morgan Schrack built his in 14 months and some 2,500 man-hours.

The fuselage is welded of 4130 steel tubing, wood-faired and fabric covered. The wings use two spruce spars, ribs of quarter-inch plywood and fabric cover. All four carry ailerons, those in the upper wing being operated by pushrods from the lower pair which are connected by torque tubes to the control sticks. The original trimmable stabilizer has been replaced with a strut-braced unit using a trim tab on the elevator. Fuel is carried in a 19-gallon tank in the upper wing center section, which gravity-feeds to another 30-gallon tank ahead of the instrument panel. This one gravity-feeds the carburetor, and no fuel pump is installed. With 49 gallons available the Starduster Too has outstanding cross-country range.

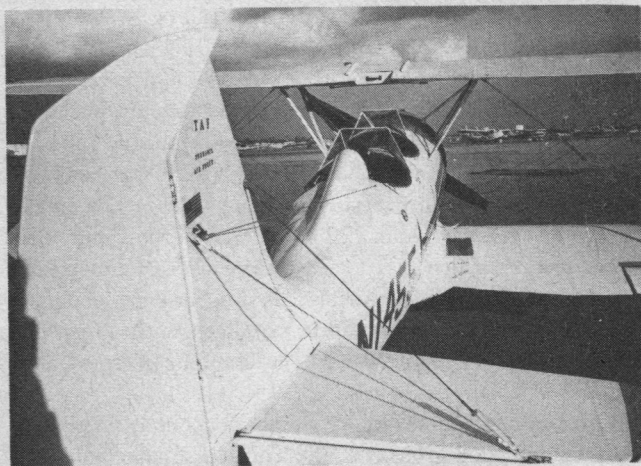
With a 180-hp engine, empty weight is about 1,025 pounds and recommended gross is 1,750. The 162 square foot wing area results in light wing loading and good short-field performance. Stolp built one airplane with a 230-hp Conti-



Rugged fuselage construction of welded 4130 steel tubing makes this biplane a toughy.



The Starduster Too weighs 1,025 pounds empty with the Lycoming IO-360 engine installed.



Lines of the Starduster Too are reminiscent of a World War II primary training plane.

mental which has exceptional takeoff and climb performance. When flown with two aboard for this report it was off in less than 50 yards and showed an initial 2,000 fpm. With power at 22.5 inches and 2,250 rpm — normal cruise setting for this engine — it climbed at 500 fpm at 100 mph indicated. Cruise speed ranges from 132 to 137 mph on 230 hp, and on 180 hp top speed at 5,000 feet is given as more than 150 mph.

Though not designed or offered as an aerobatic airplane, the Starduster can perform aerobatics in competent hands. It is relatively docile on landing as biplane taildraggers go, with the stall coming at below 50 mph. There are no flaps, but flying an approach at 85 and slowing close in, the throttle will control sink quite positively. Visibility is reasonably good even from the rear seat.

California builder Jack Swan built his Starduster Too with a clear canopy over both cockpits, and installed a retractable main gear which folds into the fuselage in a manner similar to that used on the Cessna Centurion and Skymaster airplanes. Jim Osborne, owner of Stolp Starduster Corp., plans to offer a blown sliding canopy in the near future. He can already supply all raw material and a number of complex parts which the average homebuilder finds difficult to fabricate. Among them are the nose cowl and wheel pants, fuselage turtleback, windshields, fuel tanks and axles. Spar kits and other components also are available.

Starduster Too is the big bird of the family: the similar but smaller Starduster SA-100 is a single-seater intended for the Lyc 125-hp engine, but it has been built with power ranging from 85 to 170 hp with a constant speed prop. Complete plans for Starduster Too are available from Stolp Starduster Corp., 4301 Twining, Flabob Airport, Riverside, Calif. 92509. Drawings for the Starduster Too are \$75. ●

Starduster Too

Wing span, ft.:

Upper: 24'

Lower: 20'5"

Length: 19'6"

Height: 8'

Wing area: 182 sq.ft.

Gross weight: 1,750 lbs.

Empty weight: 1,025 lbs.

Engine: Lyc. 180 hp

Wing load: 10.8 lbs./sq.in.

Power load: 9.7 lbs/hp

Fuel capacity: 49 gals.

Top speed: 150+ mph

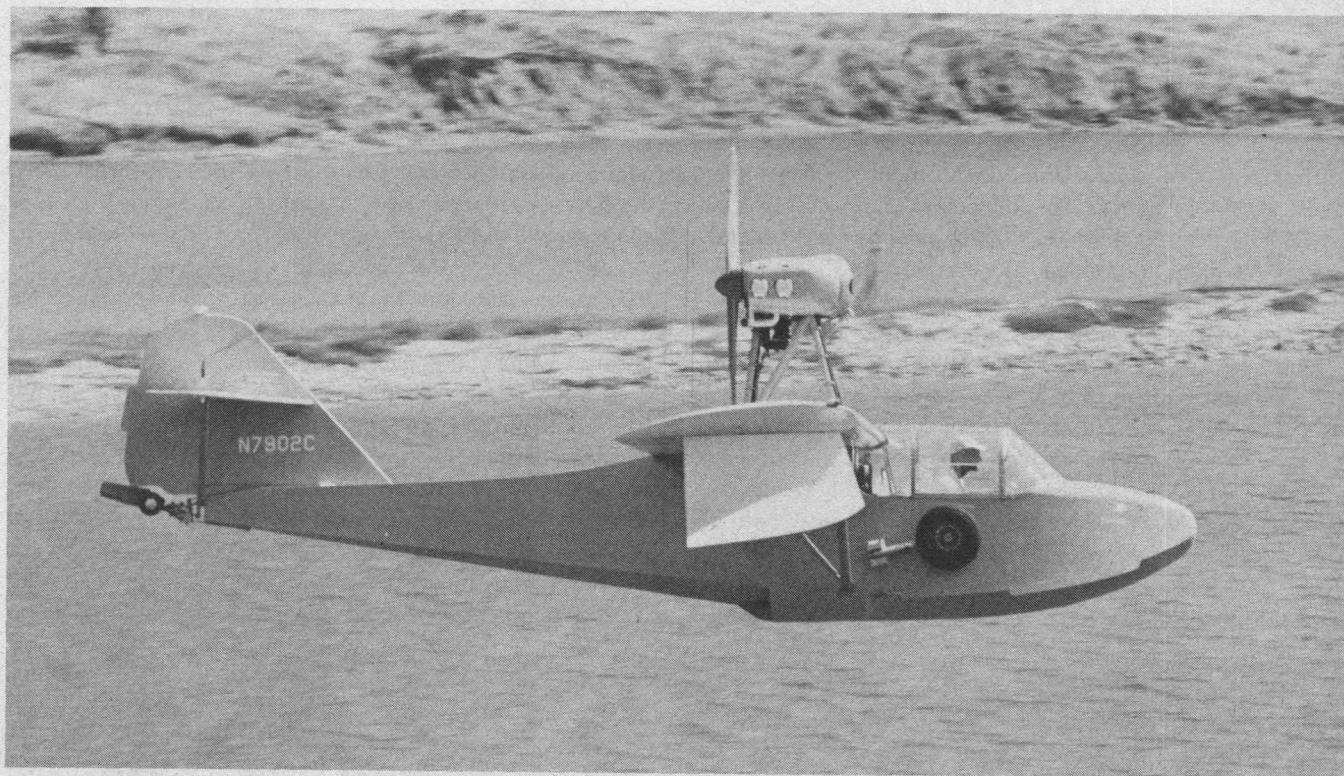
Cruise speed: 130 mph

Stall speed: 60 mph

Rate of climb: 1,750 fpm

Range: 650+ st.mi.

The Go-Everywhere Airplane



WITH SOME 800 sets of plans sold, more than 50 airplanes already flying and another 200 actively under construction, Volmer Jensen's two place Sportsman amphibian has to be called one of the more successful homebuilt designs around. And there is a one-word reason for it: practicality.

For the recreation-oriented pilot who wants to operate from runways but still have access to the vast stretches of coastal waterways, inland rivers and lakes of North America, the Sportsman offers an answer. Building it costs about one tenth as much as buying a comparable airplane, and salt water can't hurt its fibreglassed plywood hull so corrosion is no problem. It is essentially a small flying boat fitted with wheels which can be exchanged for skis, and it opens up virtually every travel and recreational horizon there is.

Do I sound prejudiced? Well, I may as well confess right now to a bias in favor of wood-hulled amphibious flying boats, because I like to fish, get away from crowds and

explore out-of-the-way places along the Gulf coast, the shores of Baja California and the northern lakes. But I like to have wheels when I want them, and one tenth the cost of anything sound like a bargain to me. All this prompted me to anything sounds like a bargain to me. All this prompted me to call Jensen at his Burbank, Calif., industrial model shop, and wangle a ride to Catalina Island in the Sportsman. flimsiest pretext to go flying, so the next afternoon we were off from San Fernando Airport where he keeps the bird.

The capsule results of our flight are these: with the 100-hp Continental now installed to replace the original 85-hp engine, the Sportsman gets off the water at gross in 20 seconds with virtually no wind. We climbed at about 300 fpm: if pressed the airplane will do twice that. Cruise speed is about 83 to 85 mph. I think our water touchdown in ground effect was slower than the 45 mph stall speed Jensen lists. Handling on the water is extremely good: a very short water



Lineup of popular VJ-22 Sportsmans at flyin.

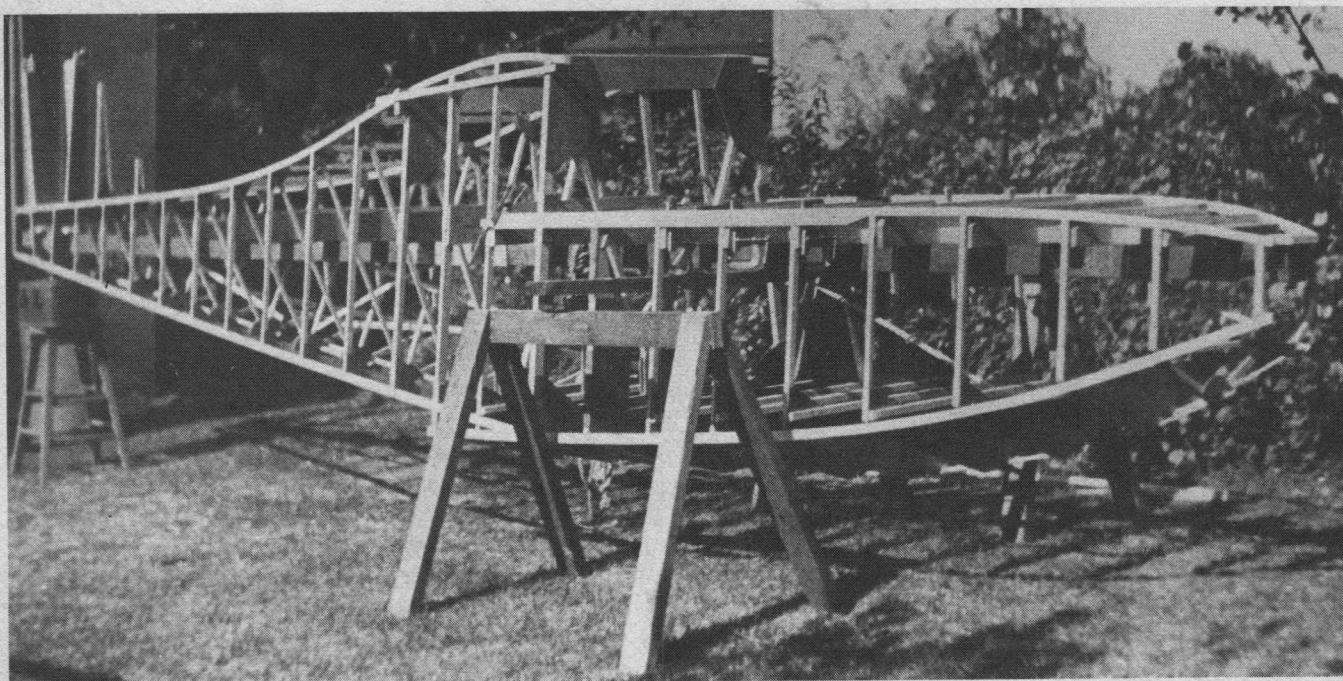
runout can be made by skidding into a turn soon after touchdown. The cockpit is comfortable and not overly crowded, though it is noisy. Visibility is first class. In-flight handling is highly responsive: I found the rudder almost too sensitive. The Sportsman uses fabric covered Aeronca Chief or Champion wings, and those huge ailerons create definite but not objectionable adverse yaw. The high thrust line causes absolutely no stability problems with abrupt throttle travel. The long wheel base and low landing speed make runway landings no problem at all, and it is an absolute thundering blast to come in over a beach or lake shore and skim the Sportsman on for a water landing.

Jensen figures the average homebuilder will use up about two years and about \$2,000 constructing a Sportsman, depending on how much of a bargain-hunter he is.

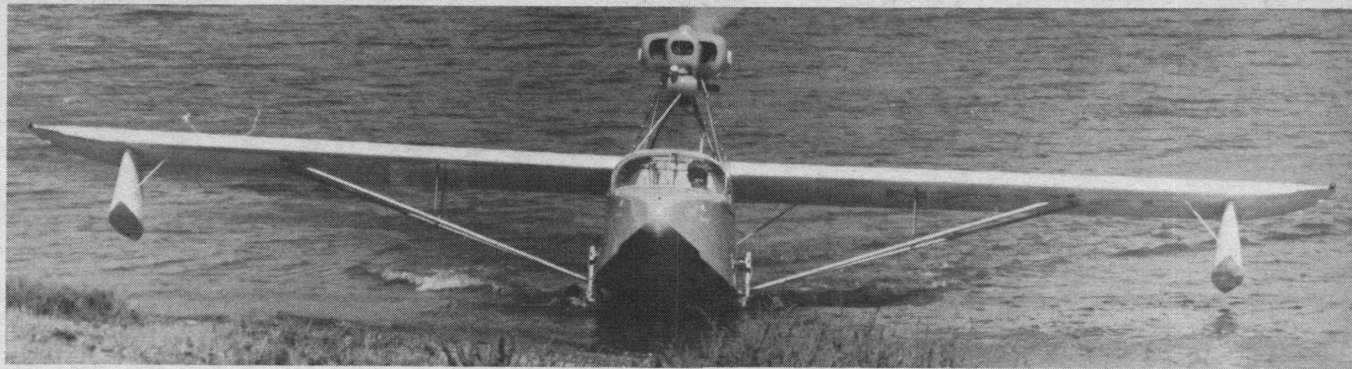
The hull is constructed of spruce longerons and frames with plywood bulkheads. The bottom is 1/4-inch plywood, and the balance of the exterior is 1/16 and 3/32 plywood, with a light fiberglass covering and automobile enamel. The interior of the hull is varnished. In the 16 years the prototype has been flying it has never leaked, and never has been

revarnished. Jensen reports most builders are highly satisfied with their Sportsmen, but notes two problem areas: weight and engine changes. Several builders have added up to 200 pounds or more over the design empty weight of 1,000 pounds, and wondered why performance suffered with two big men and full fuel. Several Sportsmen are flying with engines mounted as tractors, and with different thrust lines. Jensen notes that this requires raising the engine higher so the prop will clear the fuselage top, and advises against it.

For the money, the Sportsman will let you fly into and back out of more fun spots than just about anything else around. If it were faster and carried four, I'd be out in the garage sawing and glueing right now, but my wife and two boys would leave town if I built an airplane they couldn't all fit in. For those of you who don't have this problem, plans and periodic bulletins are available from Volmer Aircraft, 103 East Providencia Avenue, Burbank, Calif. Plans total 250 square feet of drawings on 17 sheets, plus 80 construction photos showing all major steps. Jensen also can supply nose cones and instrument panels of fiberglass, and the set of landing gear scissors. Cost of plans is \$125 for 80 and 90-hp



Wooden construction makes a Sportsman easy to build in two years by amateurs.

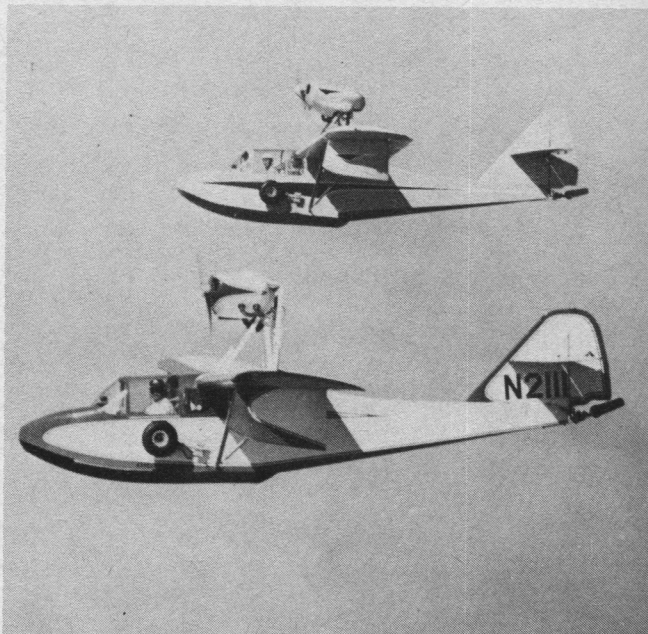


Sportsman taxis from water onto beach.

versions, and \$175 for the 100-hp model with revised and strengthened engine mount. one additional cost item is the Aeronca wings: some builders find them for as little as \$50. Jensen paid \$300 for his, used: he says he has heard of no one paying more. New wings also can be purchased from Champion Aircraft Company. •

VJ-22 Sportsman

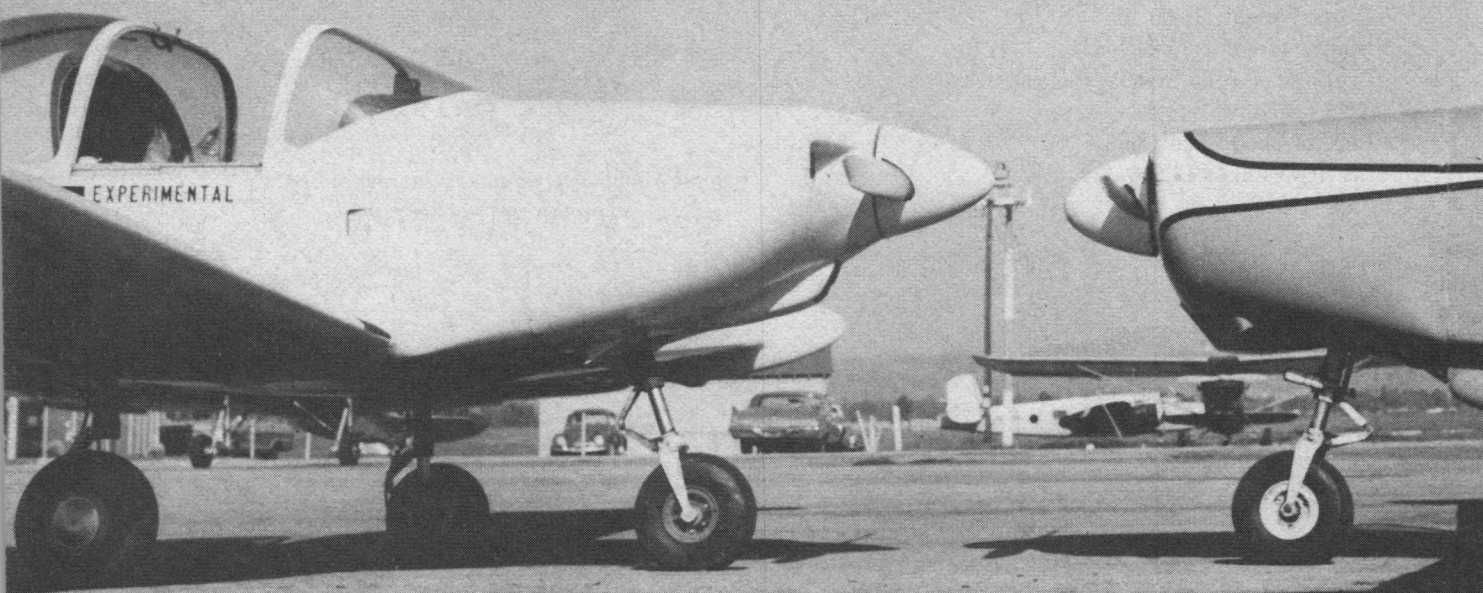
Wing span: 36'6"
 Length: 24'
 Height: 8'
 Engine: Cont. C-85
 Fuel capacity: 20 gals.
 Gross Weight: 1,500 lbs.
 Empty Weight: 1,000 lbs.
 Cruise speed: 85 mph
 Stall speed: 45 mph
 Rate of climb: 600 fpm
 Service ceiling: 13,000 ft.
 Range: 300 st. mi.



Some VJ-22 Sportsman builders mount the engines in tractor, not pusher style.

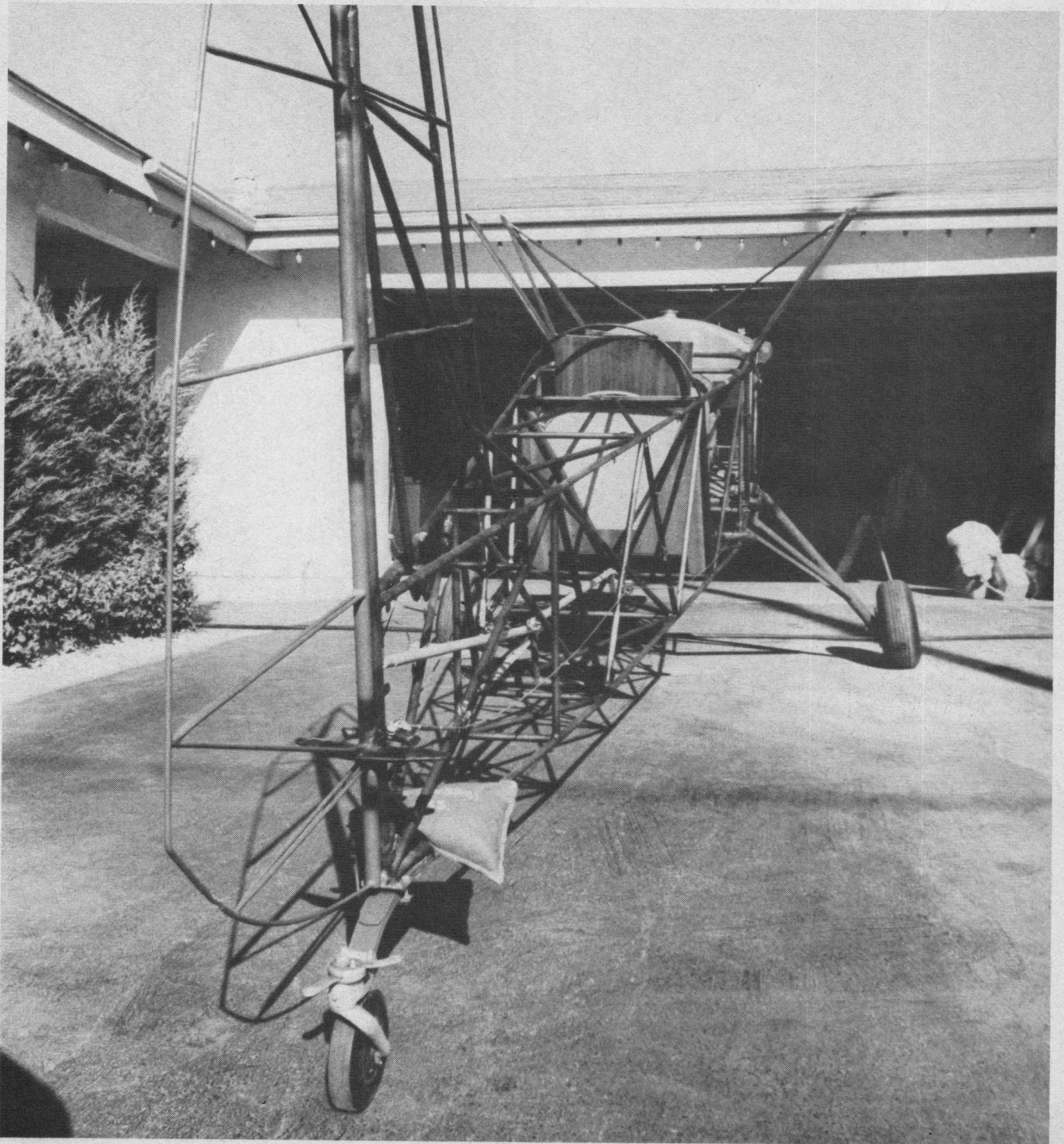


For \$2,000 you can build an amphibian that would cost 10 times as much to buy.





*Gracefully swept wings with four ailerons
give good aerobatic control response.*



*Steel tubular construction of Starduster
Too is fabric-covered after welding.*



The Breezy For Fun



MINIMUM STRUCTURE and maximum fun are the formula for Breezy, many examples of which have been built since Charles Roloff, Carl Unger and Bob Liposky built the first one in Chicago in 1964. Plans are available for \$25 from Roloff at 8748 South 82nd. Court, Hickory Hills, Ill. 60457.

Breezy is a three-place airplane with two seated abreast on the second seat, but it could easily be adapted as a single-seater or tandem two-seater. The original used a Piper Super Cruiser wing, and the designers recommend use of this or a similar wing from a high-wing aircraft rather than fabricating a new wing.

The first Breezy had an empty weight of 700 pounds and grossed 1,200 for a useful load of 500 pounds. It used a Continental C-90-8F-P, and the designers recommend that no more than 90 hp be used. If the ship is modified as a single-seater, 65 hp would be ample.

Construction took the three builders six months of evening and weekend work — about 1,500 man-hours. But much of this was engineering and development time, and they estimate that construction from plans would take about one-third this time. Cost of the original was \$3,400, but this included \$1,500 for a factory zero-time engine, \$600 for radio, \$200 for tires, tubes and wheels, \$200 for instruments and \$105 for a propeller, all new. Use of suitable used components should reduce construction cost by two-thirds.

A glance at the illustrations will suggest that apart from

welding, there is nothing much about the construction of Breezy that would trouble the average craftsman. And you can always hire the welding done. It is an easy bird to fly, as well, but you have to remember to wear goggles and keep your pockets buttoned, as the wind gets pretty stiff at Breezy's 75-mph cruise speed. •

Breezy

Wingspan: 33'
Length: 22'6"
Height: 8'6"
Wing area, sq.ft.: 165
Engine: C-90
Gross weight, lbs.: 1,200
Empty weight, lbs.: 700
Wing loading, lbs./sq.ft.: 7.3
Power loading: 13.3
Fuel capacity, gals.: 18
Top speed, mph: 105
Cruise speed, mph: 75
Range, miles: 250
Service ceiling, ft.: 15,000
Takeoff roll, ft. (turf): 450
Takeoff over 50 ft.: 1,100
Landing roll, ft.: 300
Landing over 50 ft.: 1,100



The Amazing Headwind

MOHAWK AIRLINES COPILOT Don Stewart, jetting down the beautiful Mohawk Valley in upstate New York a few years ago, gazed down on the breathtaking expanse of cornfields and apple orchards from 25,000 feet, admiring the world basking under a warm summer sun.

"Man," he yelled, "what a day to be out flying!"

It did not occur to him until later that his comment neatly spelled out the vast difference between commercial jet age aviation and sports plane flying, an exhilarating form of sky travel unique for several reasons.

First, in cavorting through the low sky in a sports plane one feels a part of the world below him, senses the smells of new mown hay, of burning leaves, of the moist earth strong in the nostrils.

Second, in flying a homebuilt aircraft one has the joy and satisfaction of creativity at work, for while sports plane flying today is recognized as a spectator sport, it gives fullest measure of enjoyment to the pilot, who has given wings to his imagination by creating a wonderful flying machine of wood and wire and fabric and taking it aloft to soar free as a bird over hill and dale and river.

Thus was born the **Headwind**, a rara avis whose virtue is not high speed nor altitude performance but utter simplicity of design and construction and ease of handling. It is the brainchild of Don Stewart, a 43-year-old father of four active children whose understanding wife, Elizabeth, encourages him in his hobby. Stewart lives, breathes and loves flying, and to really understand what makes the Headwind exceptional, one must understand the man who created it.

Stewart is deadly serious about one thing — living life fully by throwing all his energies into whatever he undertakes. Tempering his concentration is a rare sense of humor that appears in sudden laughter when he and a neighbor, Mohawk Copilot Tom Raybourn, are at work in their homebuilt "factory" — behind the Stewarts' lovely rural home, near Salem, Ohio.

"Don't think we're crazy," Stewart grinned when I visited him one day. "We always act this way!"

Liz Stewart came out of the farm-style kitchen carrying a tray of sandwiches and beer and milk and set it on a table in the backyard, a sloping green leading down to a crystal stream and a New England stone fence, shaded by towering maples. It was a typical "homebuilt haven," a bit of backyard America where for two centuries Yankee ingenuity has

flourished and mechanically minded dreamers have designed and built everything from guns and butter churns to perpetual motion and flying machines.

In the tradition of the Wright Brothers, homebuilt enthusiasts today frequently construct their own wind tunnels, strain gauges and other paraphernalia with which to fashion dream ships often incorporating new and untried aerodynamic principles. More often, however, builders like Stewart and Raybourn adapt proven ideas, combining known elements to fashion their machines from tried and true designs.

Like many of his contemporary enthusiasts, Stewart was bitten by the flying bug in boyhood, which he spent in the pleasant Green Bay region of northern Michigan. "I always tried to simplify my model airplane designs," he recalls. "I found that if I figured long and hard enough I could usually find a way to make one part serve for two."

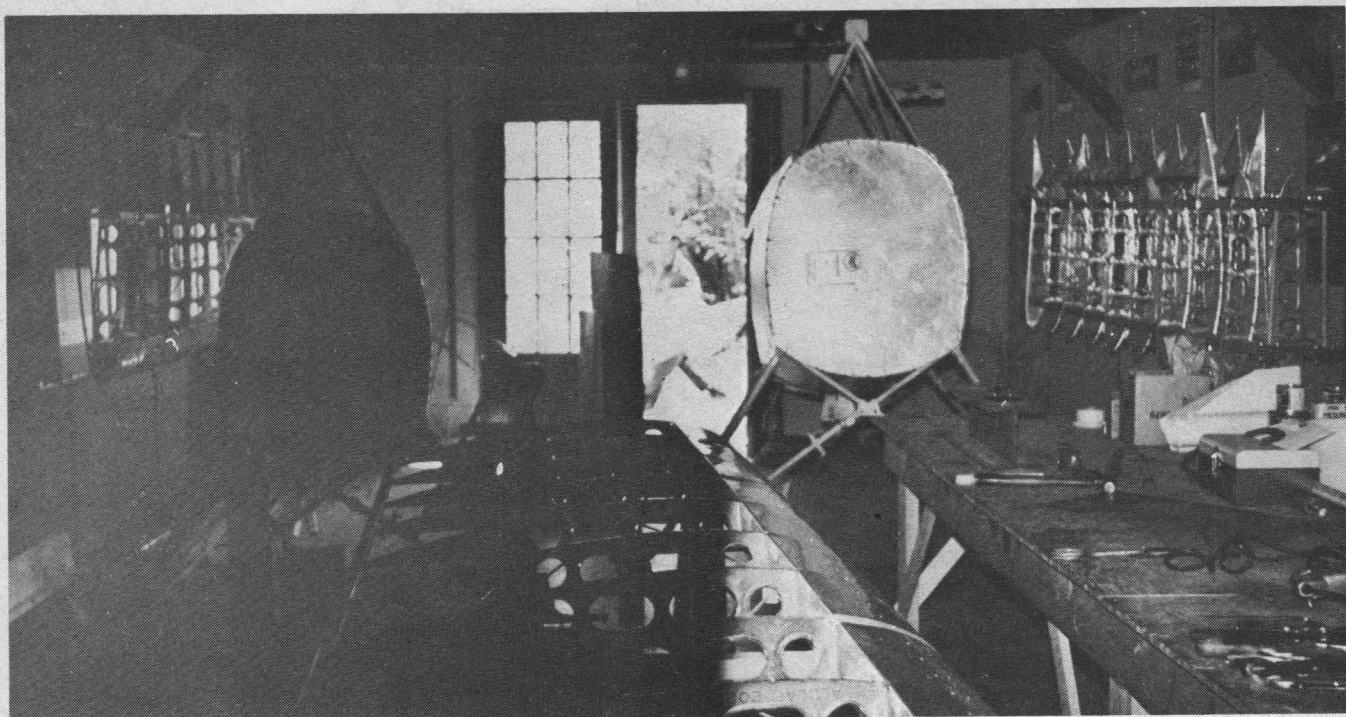
Stewart finally took up man-size aviation in 1945, paying for flying lessons by pumping gas at Menominee Airport. His enthusiasm for designing planes persisted, and for some time he experimented with a variety of combinations of low, mid and high-wing types while in high school. His only formal engineering education, however, was an I.C.S. correspondence course in aeronautical engineering. "I learned to read blueprints and airfoil charts," he says. "It was enough to get started."

All this time Stewart carried his dream of the perfect simple homebuilt airplane, and while its shape grew in his head and on paper, a search went on for a "decent engine." He finally settled on a 36-hp Volkswagen powerplant.

After 10 years of planning, construction on the Headwind began in October, 1961, and on March 28, some five months later, he finally got it off the ground. "It was Liz's birthday," he remembers. "We had a double celebration!"

The first flight was something, he recollects. "I taxied up and down the runway and found the engine would turn up about 2,700 rpms under static thrust. But when I took off and got out of ground effect the rpms stayed right there! I staggered around a silo and got back to the field at Menominee. I knew right away what was wrong. I needed a bigger prop, and a reduction jack shaft so the little engine could swing it."

Stewart discussed the problem with a friend, Bob Hugins, in Tulsa, Okla., who has designed a reduction gear with



This was the airplane factory where the Stewart Headwind was initially assembled.

a rotating shift. Stewart decided on a different approach and used a fixed shaft with a belt drive to give a reduction ratio of 1.6 to 1. With this, Stewart figured he could develop 36 horsepower at 3,600 rpms at the engine and 32 horsepower at 2,200 rpms at the prop, where before he could get only 18 working horsepower. Presently he is designing a new propeller of 62 inches diameter and a Clark Y airfoil.

"With the first installation it was a wonder the Headwind flew at all," he laughs. "I guess there's where I got the idea for the name!"

Discussing the prop speed reducer, Stewart said: "It's a different concept I worked out so there is positive lubrication of the unit regardless of the attitude of the airplane.

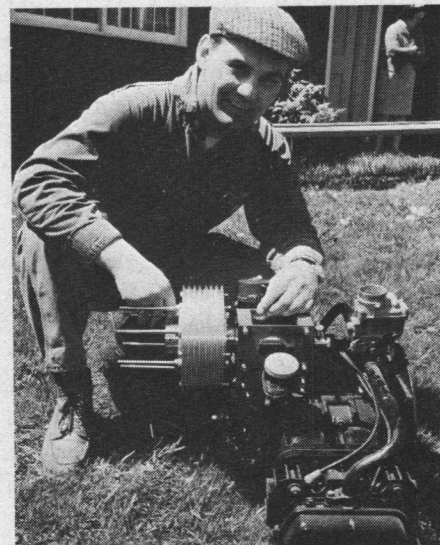
This is accomplished with no pumps or other devices. It is basically a belted arrangement and the belt tension and alignment can be adjusted at one point without disassembling the unit."

The positive lubrication feature is achieved by a series of internal agitators that splash oil over the moving parts automatically whenever the unit is turning. It, too, exemplifies Stewart's philosophy of simplicity of design.

The Headwind is described by Stewart as an "extremely simple airplane of steel tubing construction for the fuselage and tail. The wings are two wood spars with either sawed plywood or formed aluminum ribs. All the fittings are flat and only two of them require any preassembly. The engine



Don Stewart poses with VW engine, showing propeller reduction gear he designed.



Side view of VW engine and reduction gear with belt drive.

bolts directly to the front of the fuselage, saving a separate engine mount. The landing gear is rigid and uses partially deflated J-3 Cub wheels and tires. No brakes are fitted and aren't missed at all. I saved 17 pounds that way. Instead, there is a steerable tailwheel and this combination works beautifully."

The Headwind is quite comfortable for anyone except a very large person, Stewart says. "The cockpit is 24 inches wide and the cockpit sides are placed to act as armrests. Leaning out, you can actually look under the airplane, which may or may not be a first!"

The Headwind's flight characteristics were more than Stewart had hoped for: "It's not quick and skittish like a lot of homebuilts and in fact flies a lot like a J-3 or a Champ, with a very docile stall. The angle at which it stalls is quite high and I can't explain it. It probably stalls at 30-to-35 mph, though the airspeed indicator reads zero because of the relative wind over the pitot tube at that high angle."

Landing is no problem, Stewart confides. "You just watch the wheels and fly the airplane onto the ground. It's fun to watch the wheels touch, although doing this almost always causes a one-wheel landing. It's a very stable airplane on the ground, due to its low CG."

When Stewart designed the Headwind, all he could come up with for cruise speed was about 70 mph, but Headwinds built by other enthusiasts, since the prototype first flew, indicate about 80 mph in cruise mode. One, powered with a 65-horsepower Lycoming, reportedly cruised at 120 mph "and with a climb you wouldn't believe," Stewart heard.

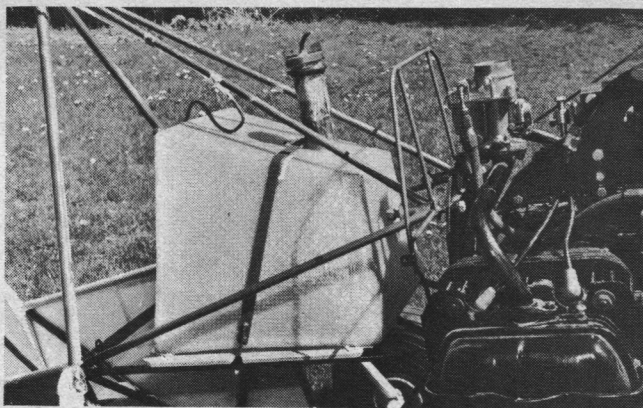
When I visited Stewart at his Salem home, he and Tom Raybourn demonstrated how quickly it could be assembled. From the time they started carrying the fuselage, wings, empennage and engine out of the red barn until it stood as a complete machine took less than 20 minutes.

I noticed several intriguing points emphasizing the simplicity of design which makes the Headwind unique. The triangular cross section of the fuselage, with two longerons at the bottom and one at the top, is a design *reductio ad absurdum*. Elimination of brakes and a shock system from the landing gear is a good weight-saver, with the fat 800-by-4 Cub tires inflated to six pounds pressure taking the landing load.

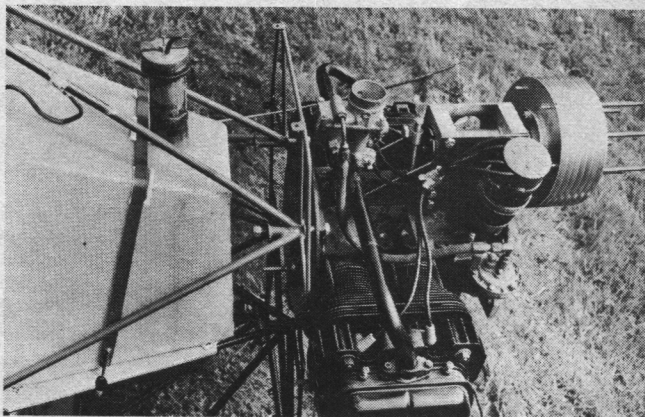
The front wing struts have been modified from an Aeronca Champ, and the flying surfaces are designed to bolt quickly to the fuselage. The pilot seat board is simple 3/8 inch marine plywood which can be upholstered to suit. The back rest is of 1/4 inch marine plywood.

Most unusual is the fuel tank, a tapered tetrahedron Stewart built of hardware cloth wire lined and covered with glass cloth and resin, giving a capacity of six gallons. A pitot vent in the gas cap, facing forward, produces two psi pressure which provides fuel flow, even without using the VW engine's fuel pump.

The engine, bolted to the fuselage frame with only four bolts, is unmodified except for the propeller reduction gear and a reversed intake manifold. Stewart prefers to stay with the VW's single ignition system: "Drilling extra holes for another set of plugs would only cut down the reliability," he points out.



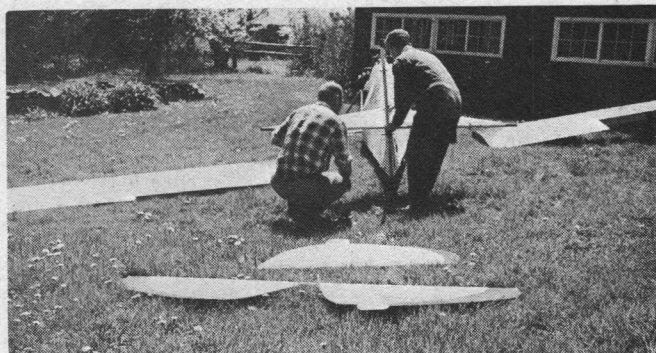
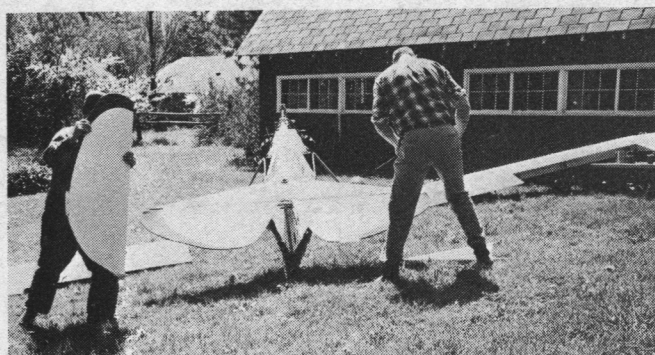
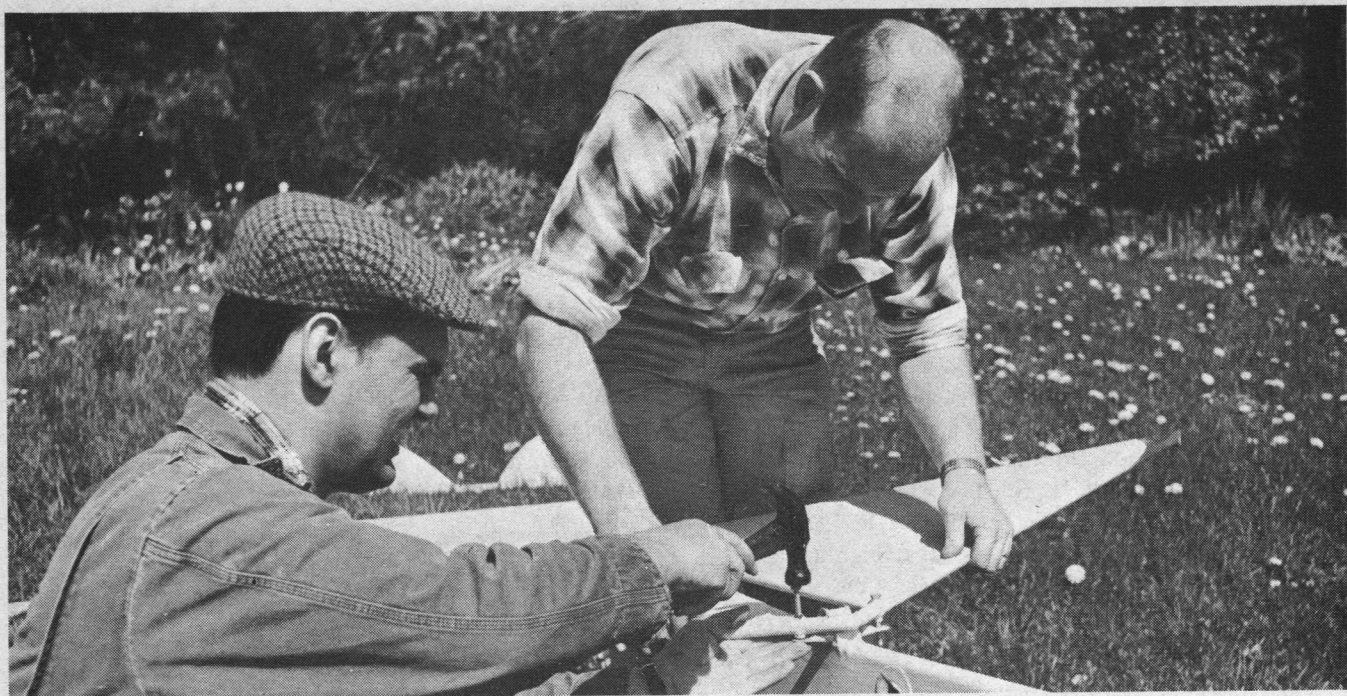
Novel fuel tank for Headwind is built up from hardware cloth wire covered with glass cloth inside and out, plus resin.



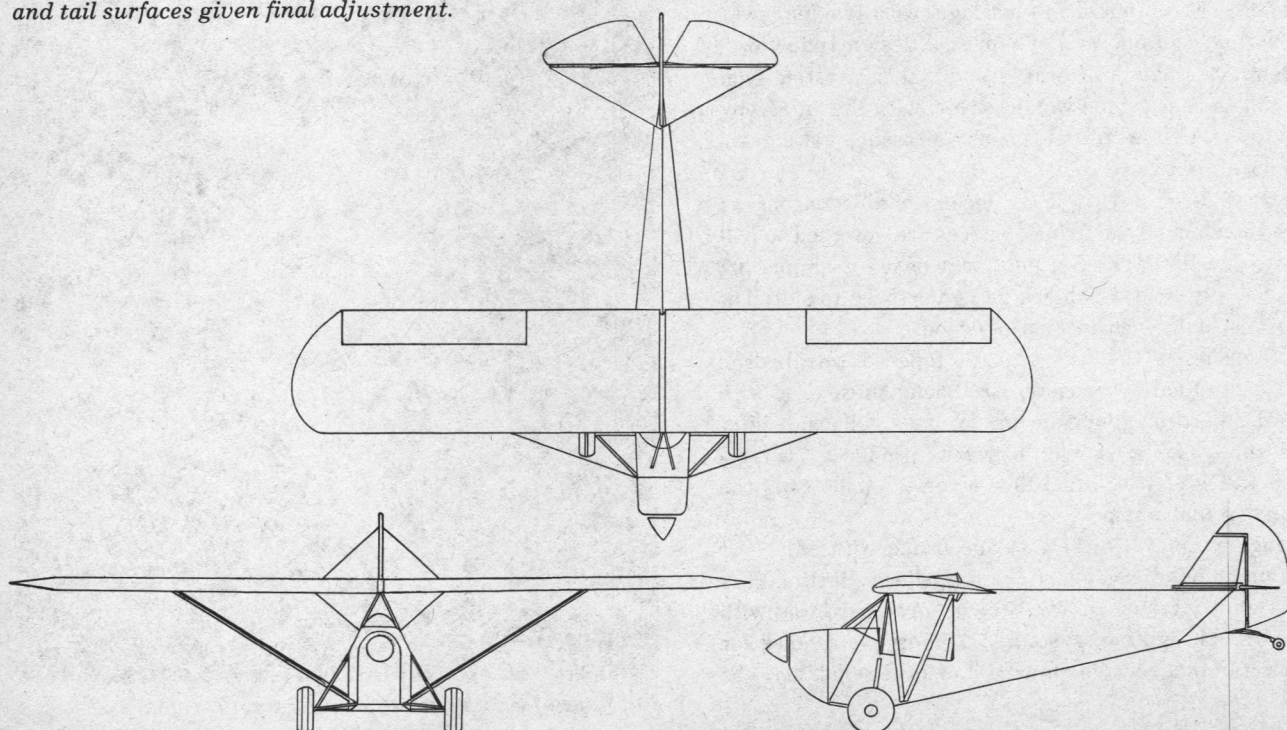
Note that VW engine bolts directly onto fuselage, eliminating need for motor mount. Fuel tank is at left.



Fuselage of Headwind is simple triangular shape.



Quick assembly: stabilizer is bolted on, vertical fin, rudder added, and tail surfaces given final adjustment.



A typical Headwind can be built for less than \$625, though some of those 10 already flying have cost more. With the new propeller reduction gear installed, Stewart computes his prototype's performance at:

Vmo at 36 hp: 75 mph
Vne at 36 hp: 100 mph
Vso at 36 hp/650 lbs.: 36/38 mph
Vmo at 65 hp: 85 mph
Vne at 65 hp: 100 mph
Vso at 65 hp/700 lbs.: 38/42 mph
Vno/both versions: 70/75 mph
ROC 1st min/36 hp: 350 fpm
ROC 1st min/65 hp: 650/700 fpm
Takeoff, zero wind: 300 ft. at 36 hp
Takeoff, over 50 ft.: 1,200 ft.
Landing run: 400 ft.
Landing run/over 50 ft.: 1,600 ft.
Fuel/reg. auto: 6 gals.
Endurance: 2:25 hrs. at 36 hp
Oil cap: 5 U.S. pints

Other Headwind Specifications:

Wingspan: 24 ft. 2 ins.
Length: 17 ft. 9 ins.
Height: 5 ft.
Stabilizer span: 7 ft.
Wheel track: 5 ft.
Wheel base: 13 ft. 6 ins.
Wing area: 94.5 sq.ft.
Ailerons (two): 14.4 sq.ft.
Fin: 2.17 sq.ft.
Rudder: 4.77 sq.ft.
Stabilizer: 7 sq.ft.
Elevators: 9.54 sq.ft.
Empty weight: 426 lbs.
Gross weight at 36 hp/650 lbs.
Gross weight at 65 hp: 700 lbs.

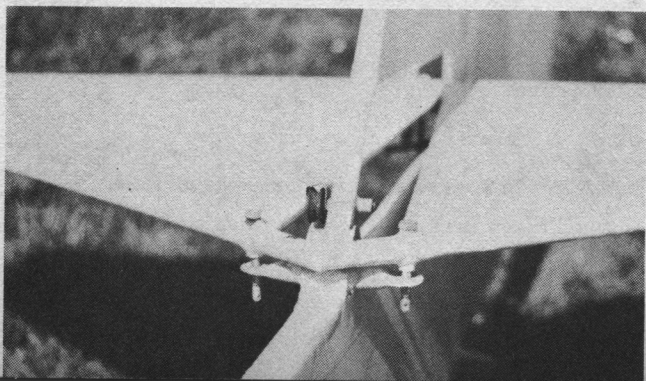
Headwind Rigging & Settings:

Wings

Incidence/root: plus 2 degrees
Incidence/tip: plus 30 minutes
Dihedral/front spar: plus 2 degrees

Stabilizer

Incidence/(nominal): minus 1 degree 30 minutes
Dihedral/rear spar: zero degrees



Fin

Incidence/right plus (nominal): 20 ft. at 36 hp
Incidence/left minus (nominal): 20 ft. at 36 hp
Incidence/right plus (nominal): 30 ft. at 65 hp
Incidence/left minus (nominal): 30 ft. at 65 hp
Dihedral/rear spar — ref. stab.: 90 degrees

Engine

Thrust: zero degrees, all axis, VW install.

For installation details contact:

R.G. Huggins
4915 South Detroit
Tulsa, Okla.

Propeller

R. Hegy
Marfa, Tex.

Ailerons

Up: plus 15 degrees
Down: plus 15 degrees

Elevators

Up: plus 35 degrees at 36 hp
Up: plus 40 degrees at 65 hp
Down: minus 25 degrees, both

Rudder

Right and Left: 30 degrees

Tires

800 x 4 (nominal): 6-12 psi

Control Cables

Aileron tension plus/minus 5 lbs.: 20 lbs.
Elevator tension Plus/minus 5 lbs.: 30 lbs.
Rudder: spring loaded

Weight & Balance

Datum: L.E. wing
Forward limit: 8.6 ins. aft datum
Rear limit: 14.4 ins. aft datum

Limit Loading

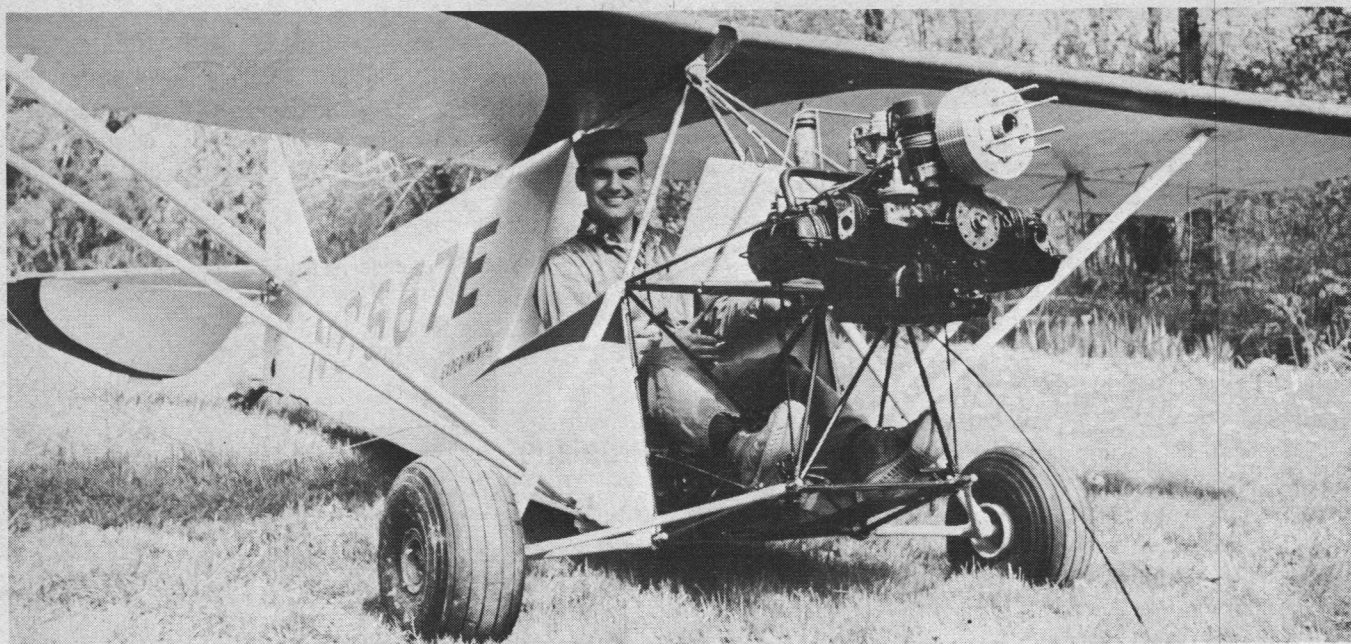
Positive factor: 6.0
Negative factor: 3.9

For material and supply sources contact:

Experimental Aircraft Association
Hales Corners, Wisc.



Details for final assembly of Headwind.



Don Stewart poses happily in assembled Headwind; note wideset landing gear that makes for good stability on ground.

Stewart and Raybourn were once members of the Experimental Aircraft Association, Chapter 294, whose members already have under construction or flying a total of 15 aircraft, including two Midget Mustangs, three Pitts Specials, a Tailwind, a Baby Ace, a Teal Amphibian and two Foo Fighters.

The latter also are products of the genius of Stewart and Raybourn. One has now taken shape in Stewart's red barn "homebuilt factory." They enthusiastically put the framework of one of them together, propped on chairs and poles, to show me what it will look like when finished.

"We got the idea by going through a book of World War I fighters," Stewart says. "I styled it to sort of look like a World War I fighter, using the Alcock as a basis for the whole airplane. People who first look at it think they recognize it and sometimes say, 'Oh, I know what kind of an airplane that is, but I can't remember the name of it now!'"

In naming the odd craft Foo Fighter, Stewart explained that "the names for my airplanes are consistent with my philosophy that sports planes are intended for fun, and what

better place to start than the name?"

Originally, Stewart wanted to build a faithful replica of a Spad or a D-VII Fokker, powered with an inverted Ranger engine, but decided against it because that way it would not be authentic. "So I decided to build a crazy combination with all the good points of several types."

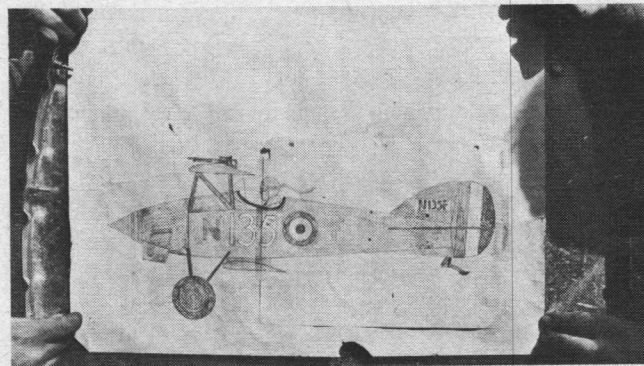
What evolved from a Snoopy-like drawing Stewart whipped up was a mongrel ship with a Bristol F2B fin and rudder; a Spad fuselage; an Albatros nose, elevator and stabilizer; and wings hung like the Alcock A1, similar to an SE5.

For power Stewart initially used a Ford Falcon engine, which he figured the average poor pilot can afford at around \$150. With the exception of a propeller reduction unit the engine is unmodified for top reality. "You just bolt it on and fly, and besides it runs on car gas," he grins.

Raybourn, who got involved with the Foo Fighter design at Stewart's invitation, is a big man, six feet and four inches, hence the two EAA members decided to "build the ship around Tom." It came out with a span of 20 feet, four inches,



Here was the way the first Foo Fighter looked in the Stewart backyard factory.



Actual "blueprint" of Foo Fighter was this happy drawing by "grownup kids."

Mini-Ace And CA-65



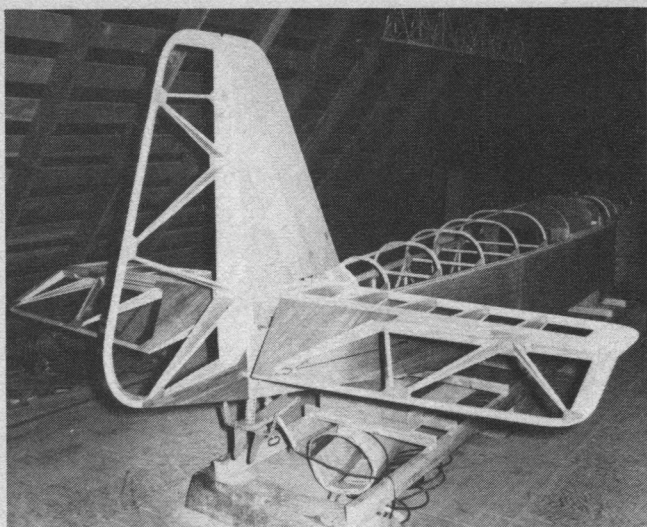
AIRPLANES, LIKE TOPSY, tend to grow. That's what happened to Anton Cvjetkovic's Mini-Ace, which started life as a wood single-seater with fixed gear and evolved into a sleek two-place retractable which can be built in either wood or metal.

The Mini-Ace, plans for which sell for \$5; is designed to be built in under 1,000 man-hours. Using either a Continental engine of 65 to 85 hp or a converted Volkswagen engine, the ship grosses at 950 pounds as a single and 1,300 as a two-seater. Top speed is 120 mph and cruise is 118 mph. Construction cost minus engine and instruments is given by the designer as under \$1,000.

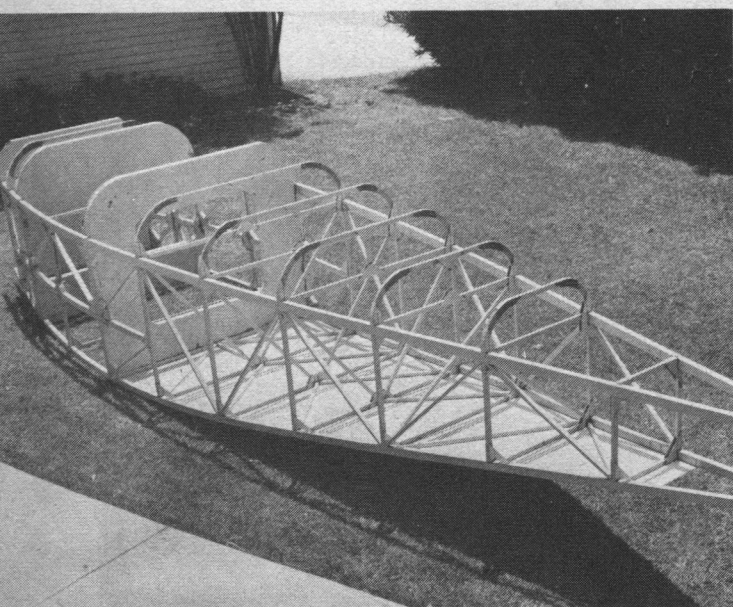
A development of the Mini-Ace, the all-wood CA-65

features landing gear retraction by a manual ratchet arrangement. Coupled with a tapered wing, clean cowling and streamlined canopy, the pull-up gear gives the CA-65 a top speed of 152 mph on 108 hp, 167 mph on 135 hp and 174 mph on the Lycoming O-320-A2C of 150 hp. With the latter engine rate of climb is 1,530 fpm, takeoff run is 325 feet and cruise speed is 150 mph.

The two-spar wood wing is built in one piece and the seats, controls and landing gear mechanism are an integral part of it. The fuselage is built of truss sides joined by bulkheads, crossmembers and formers. The entire aircraft, except ailerons, rudder and elevator is plywood covered. A great many commercially available components are designed into



Details of wood construction of tail area of the Mini-Ace show expert workmanship.



CA-65 wooden fuselage ready for covering can be built up without complex jigs.

the airplane, and Cvjetkovic says the average homebuilder could assemble one in about 1,200 man-hours at a cost of under \$1,500 not counting engine and instruments. Simplicity of construction was a design target. Examples are wing ribs gang-sawed out of plywood, and a built-up main spar that can be assembled using a leveled plank or four saw-horses as the only jig required. Plans are \$65.

The CA-65-A is the same airplane adapted for all-metal construction, and with a modified swept tail. In this version ultimate stress levels are plus 9 and minus 6 Gs, construction cost is estimated at \$1,500 without engine and instruments, and plans sell for \$110.

Cvjetkovic also sells separate plans for the manual gear retraction mechanism, which is suitable for many light aircraft of up to 1,500 pounds gross weight, for \$15, and plans for a folding-wing option on the CA-65 are \$15. His address is P.O. Box 323, Newbury Park, Calif. 91320. •



Tapered CA-65 wing is plywood-covered with no fuel tanks — they're in fuselage.







At 6 feet 4 inches, Tom Raybourn made sure the cockpit of Foo Fighter would hold him comfortably when ready to fly.

length 18 feet, six inches, height seven feet and a dry weight of 750 pounds.

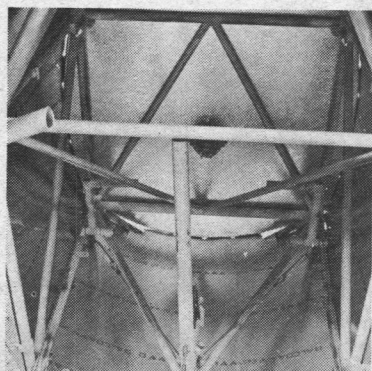
In the air, they believe the Foo Fighter really flies like something Von Richthofen himself would be proud of, with a 120 mph cruise and 2,500 fpm climb. Its high load factor will make the Foo Fighter a good aerobatic ship, but so far as they are concerned, these two happy backyard homebuilt enthusiasts get just as much fun from flying it straight and level over the pleasant countryside, white scarf flowing in the slipstream and kids waving at them from below.

Both men in fact have a fondness for children and the Stewart backyard has become a neighborhood playground

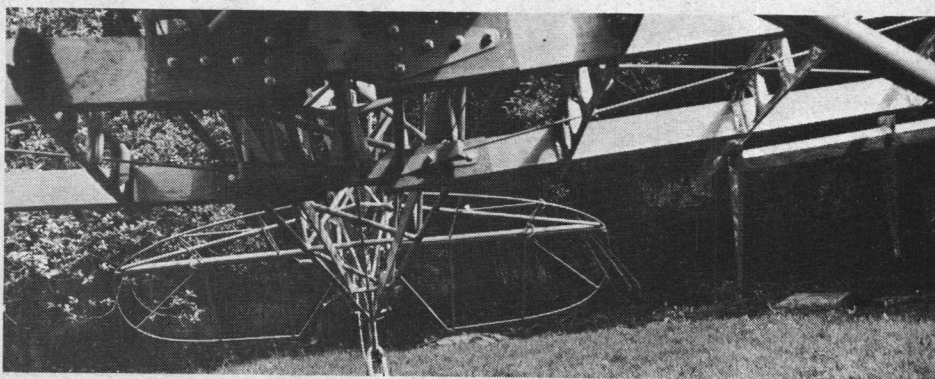
where kids gather to make wonderful make-believe flights and plan for the day when they too will find romance in the sky.

Stewart is insistent that both the Headwind and the Foo Fighter designs remain classically amateur productions, available to anyone at no cost except a small fee to cover the cost of blueprints. These are available for \$15 a set, by writing to:

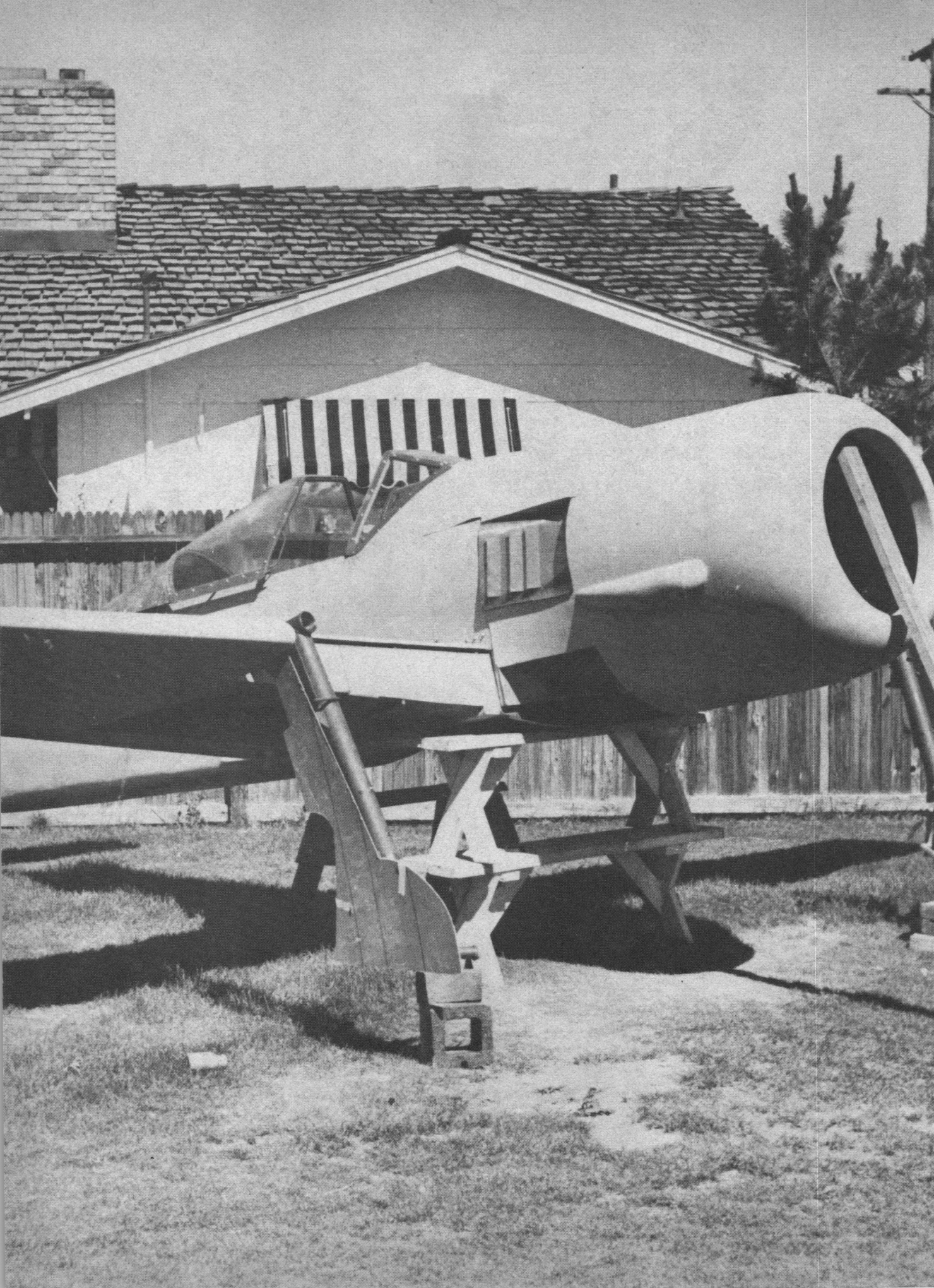
Don Stewart
11240 State Route 165
Salem, Ohio 44460



Roomy Foo Fighter cockpit, showing the control linkage.



Low view shows wood spars and metal fittings for the growing Foo Fighter.



Scale Replicas Of Great Fighters



THE LEADING COMBAT planes of the First World War were relatively small, simple to build and surrounded with a romance which seems likely to keep them perennial favorites among builders of sport aircraft.

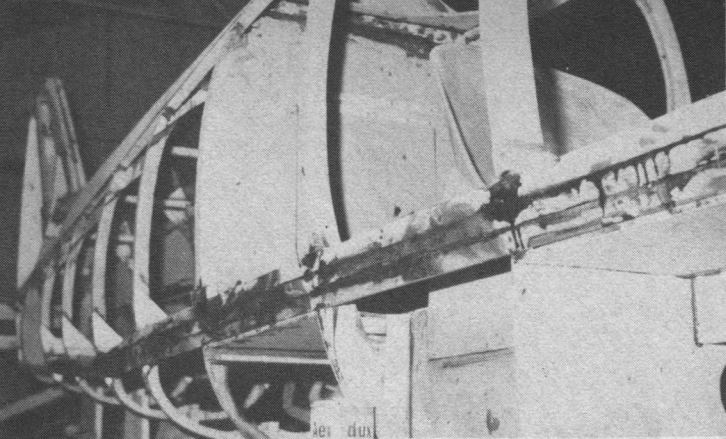
The leading fighters of World War II have, if anything, even more romance and attraction for the sport pilot. Unfortunately, however, their massive engines, complex metal structure and — in some cases — their sheer size have kept them out of range of the home builder.

But sooner or later it had to happen, and now it has: The classic fighter designs of the war are beginning to appear in scaled-down versions adapted for lightplane powerplants. Three of them, the North American P-51 Mustang, Super-

marine Spitfire and Focke Wulf FW-190, are available as plans or kits from Jurca Plans, 581 Helen St., Mt. Morris, Mich. 45458.

All three are wood designs by Marcel Jurca, a talented Frenchman widely known for a whole series of successful light aircraft. The Mustang is available as a $\frac{2}{3}$ or $\frac{3}{4}$ scale replica while the celebrated British and German fighters are $\frac{3}{4}$ scale.

The prototype MJ-7 Mustang, called the Gnatsum, was built by a group of Canadians from the first kits. Work started late in 1967 and the aircraft flew in July, 1969, with a 200-hp Ranger inline engine. Other powerplants which can be used include any of the six-cylinder Rangers, the 125-hp



Scaled-down version of British Spitfire is assembled from wood, glue, and TLC.

Menasco or 130-hp Gypsy Major of four cylinders, or the excellent six-cylinder Czechoslovakian Walter 6 III. Some interesting possibilities also exist for using automotive engines such as the Canadian Rambler of 125 to 160 hp, or the General Motors Buick F85. These engines have aluminum alloy blocks, and with a new aluminum head and suitable accessories would be light enough for aircraft use. Moreover, the necessity for installing a reduction gear ahead of the engine would allow installation of thin, pointed nose cowlings so characteristic of the Spit and Mustang.

Flight test data from a field at 2,300 msl showed a takeoff roll of 800 feet and clearance over 50 feet in 1,200 feet. With the gear down and 15 degrees of flap, initial rate of climb is 1,000 fpm, and clean it is 1,300 fpm. Clean, the stall comes at 75 mph: With gear and flaps down, power off, it is 65 mph. The landing roll is 800 feet.

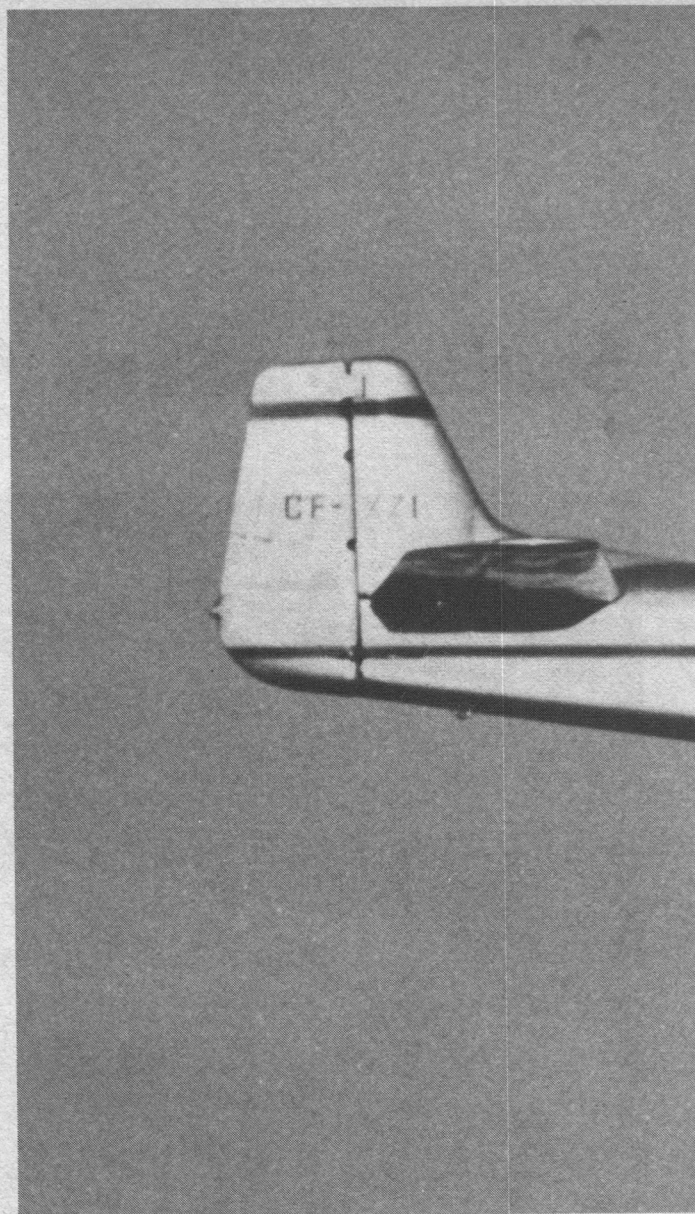
airplane which is considerably heavier than the M-7, and would probably not be licensable in Canada where home-builts must stay below 1,500 pounds gross. No such rule limits U.S. builders, and the $\frac{3}{4}$ scale version may prove much more popular in the states, particularly with the Ranger.

The basic M-7 Mustang plans show a manually retractable main gear and manual flaps, but on the prototype small electric motors are employed. Other "speed mods" include burying the flap actuating mechanism in the wing and closing the control surface gaps on the ailerons and tail group. The belly scoop was made detachable because it was feared it would create a major drag penalty, but flight tests show the scoop adds very little drag. It can nevertheless be left off and added fuel carried. With an aircooled engine the only function of the scoop is to make the airplane look right.

Construction of the M-7 Mustang is typical of several other Jurca wooden airplanes. The fuselage is built of two sides plywood covered and joined at top and bottom by formers. Extensive use of balsa wood for fillets is specified. The tail group is of plywood ribs, plywood covered.

The wing main spar has laminated flanges top and bottom, with plywood webs front and back. Ribs are plywood with reinforcing cap strips, and the entire wing is plywood covered. The structure is fully aerobatic, with a design stress factor of 9 Gs and an ultimate stress factor of 12 Gs.

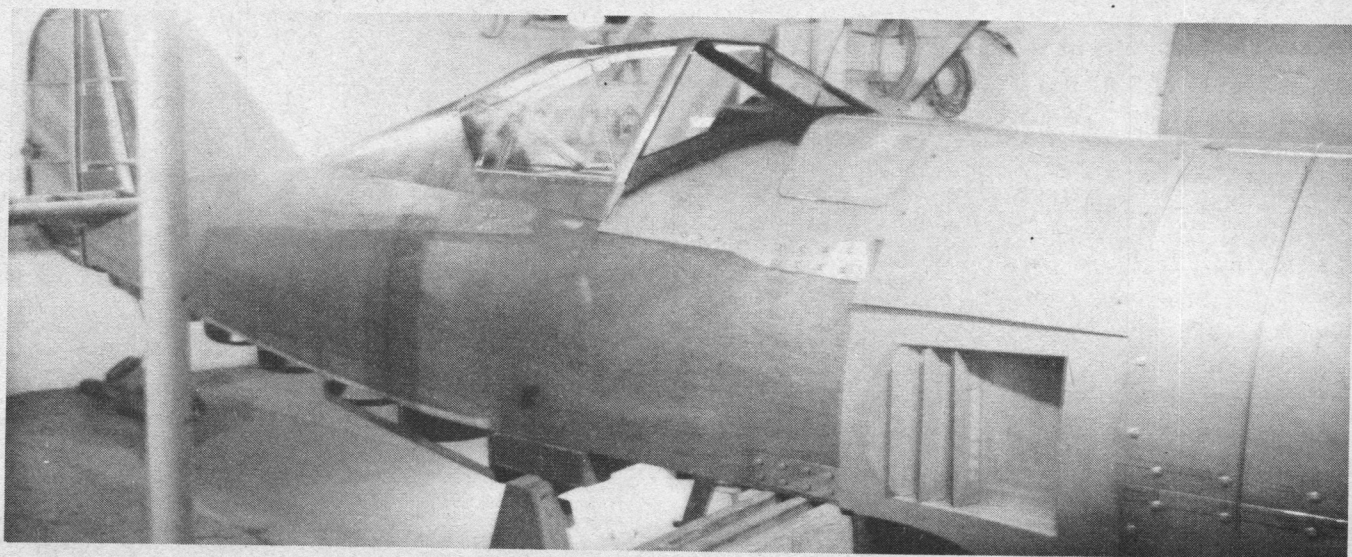
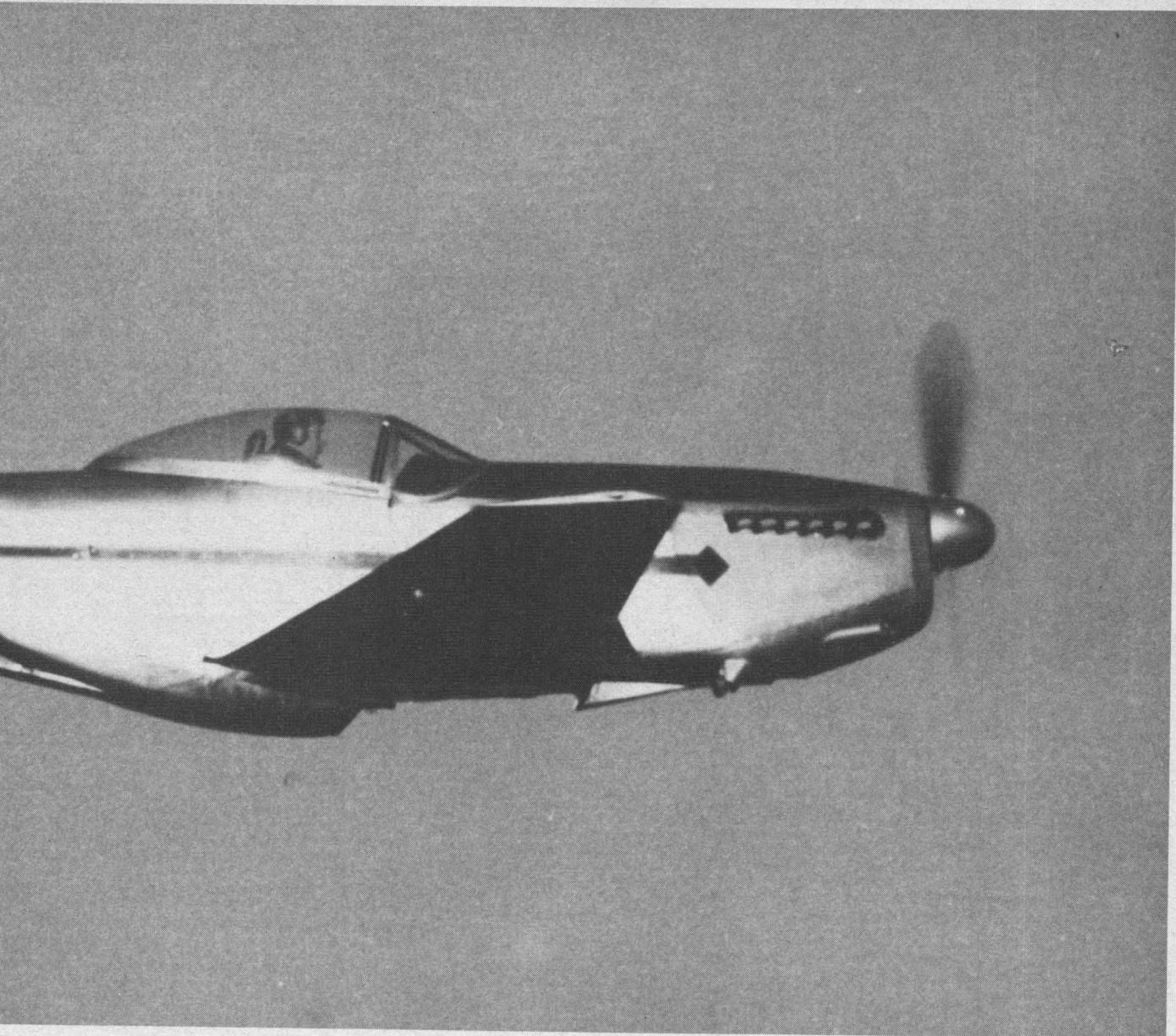
Information packets are \$2 per airplane and plans cost \$120 per plane.



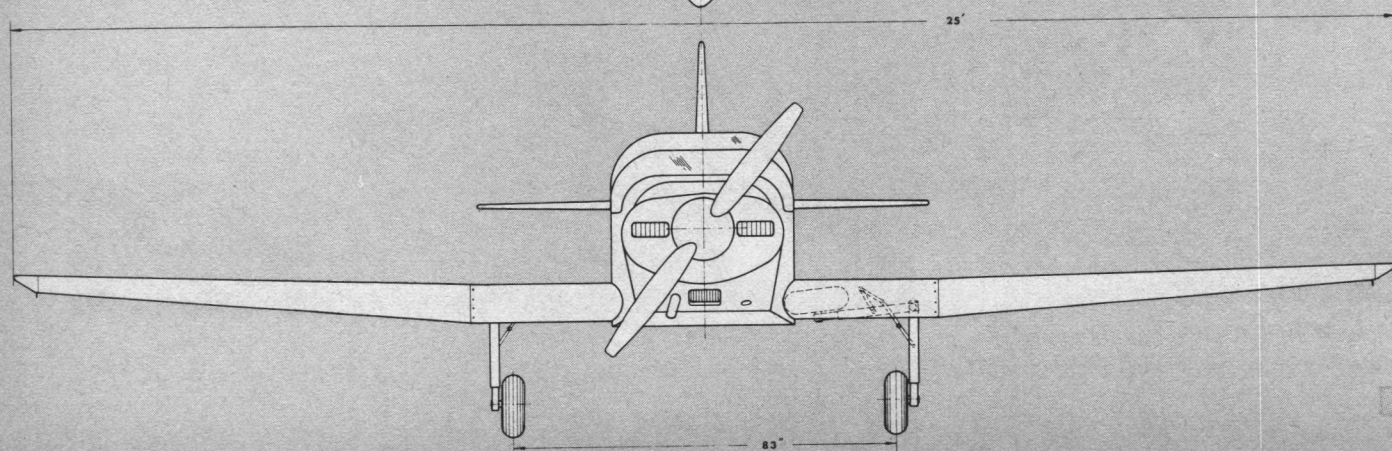
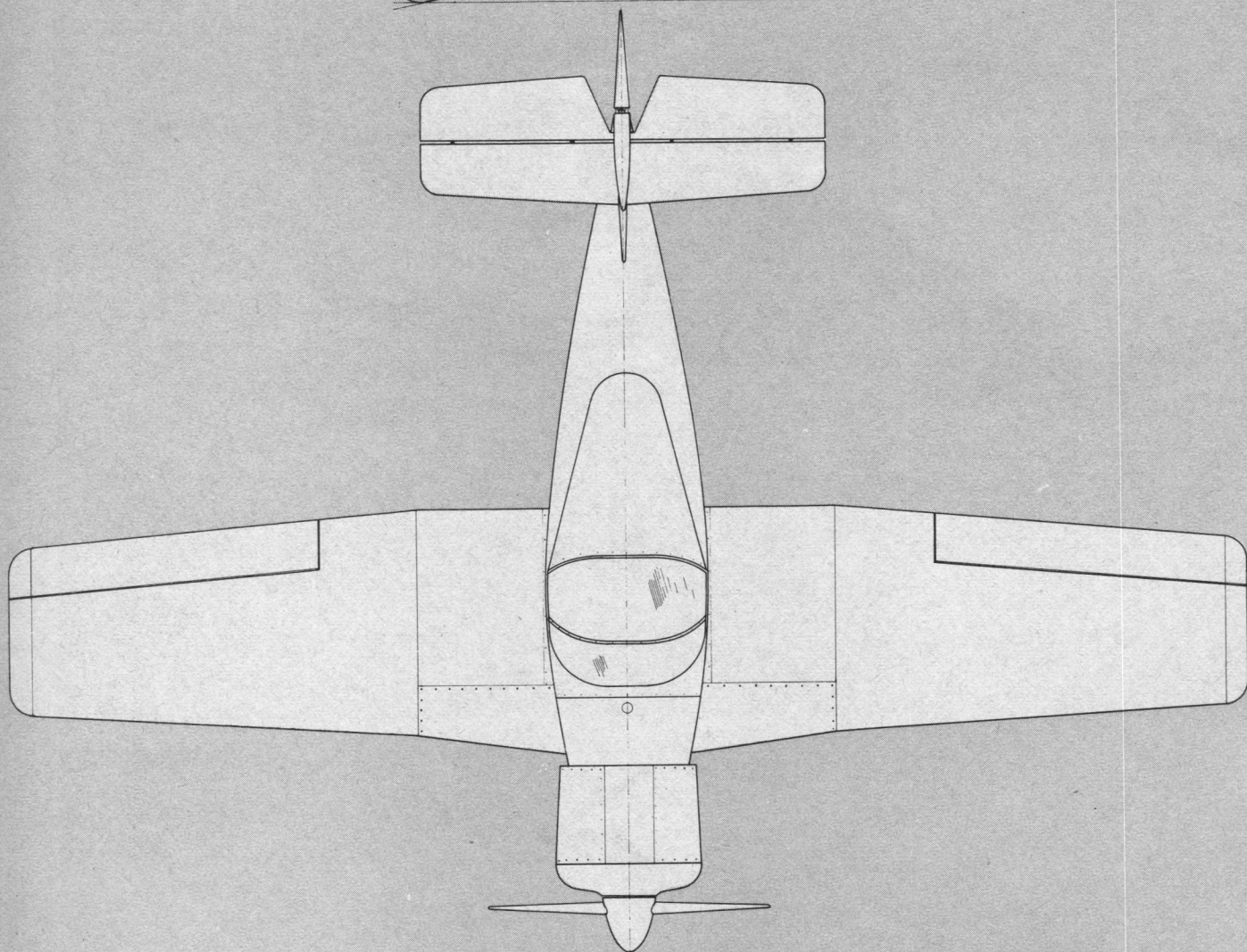
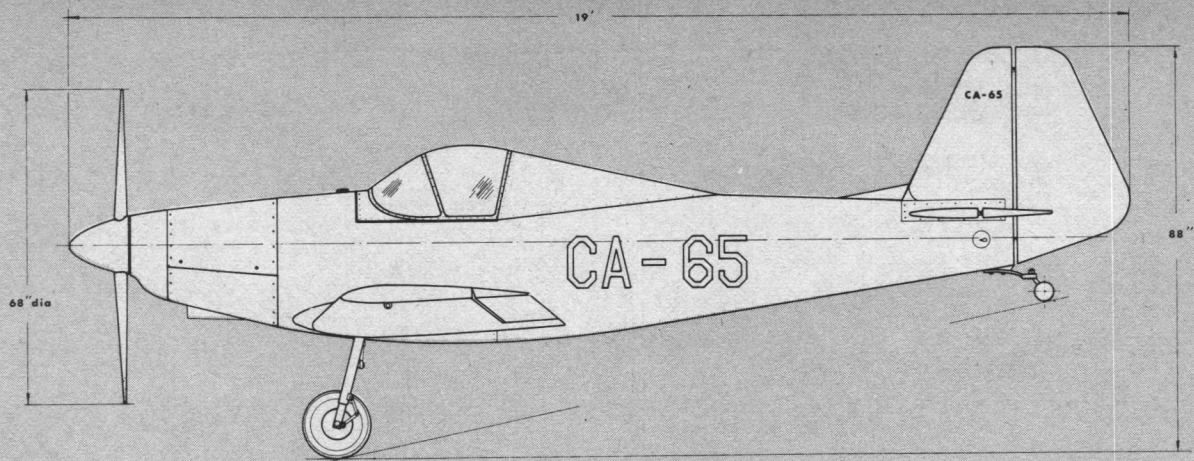
Jurca MJ-7 Mustang replica fighter is being flown by test pilot George Chiver.



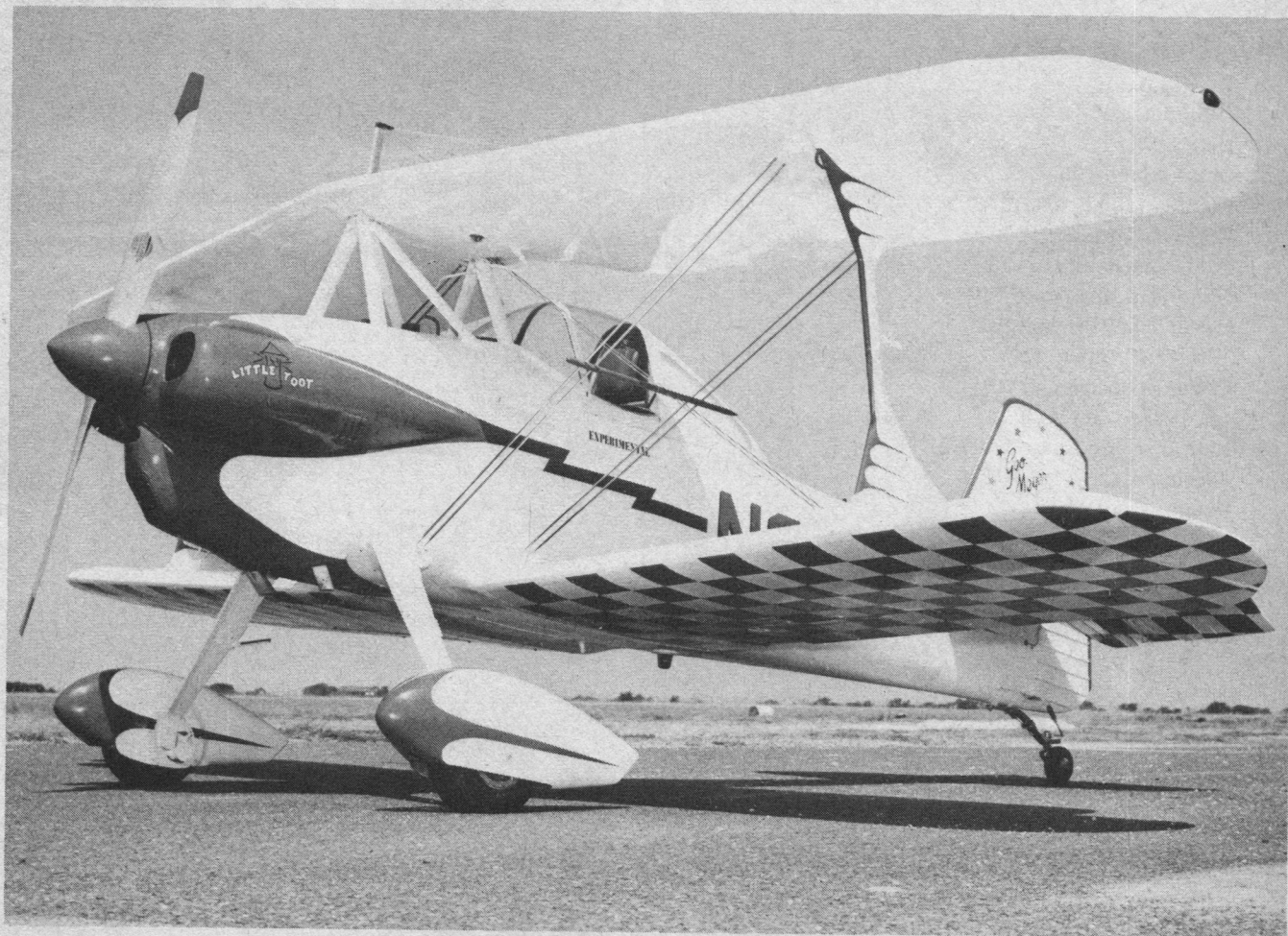
Two-thirds scale Jurca Mustang is here temporarily assembled for alignment.



*Focke Wulf-190 will fly again in peace,
when homebuilder gets dream ship finished.*



Little Toot Is A Little Beaut



GEORGE MEYER'S "Little Toot" has long been one of the nation's most popular homebuilt sport biplanes, and it continues to attract builders throughout the U.S., Canada and abroad.

Constructed with a sheet metal covered steel tube cockpit section and monocoque sheet metal rear fuselage, Little Toot uses two-spar wood wings covered with fabric. Landing gear is spring steel main gear legs and steerable tailwheel. The original was fitted with a Continental engine of 90 hp which gave it a top speed of 127 mph, cruise of 115 and a 1,000 fpm rate of climb. Meyer now has the aircraft at home

for installation of a 160-hp Lycoming with which he expects to get 150 mph top and a 2,300 fpm rate of climb.

He offers plans at \$75 per set showing both the original construction, which had a sheet metal tail, and an alternate steel tube full fuselage and tail structure for fabric cover. Wing drawings show full size ribs in either of two styles, the original plywood web and spruce cap strip or an alternate using the traditional stick and gusset built-up truss rib. Bulkheads and fittings also are shown full size and may be used as templates.

Little Toot has an eight-degree sweepback on the upper

wing, and the straight lower wing carries wide, almost full-span ailerons that give the ship an unusually high roll rate. The upper wing has no dihedral, the lower one 2½ degrees.

Meyer anticipates aerobatic performance equal to any other aerobatic biplane in existence when he has the larger engine installed in Little Toot, which has plus 10 and minus 10 G strength. He says most builders are using converted 125-hp Lycoming ground power units, but Little Toot can handle four-cylinder engines up to 200 hp. Construction cost should run \$2,000 to \$3,000 depending on engine, Meyer says. He can supply molded fiberglass engine cowlings now, and expects to be able to offer other components soon. Meyer's address is 5706 Abby Drive, Corpus Christi, Tex. 78413.

Meyer "Little Toot"

Wingspan: 19'

Length: 16'6"

Height: 7'

Gross weight, lbs.: 1,230

Empty weight, lbs.: 914

Engine: Continental 90-hp

Fuel capacity, gals.: 18

Wing load, lbs./sq.ft.: 10

Power load, lbs/hp: 13.7

Top speed, mph: 127

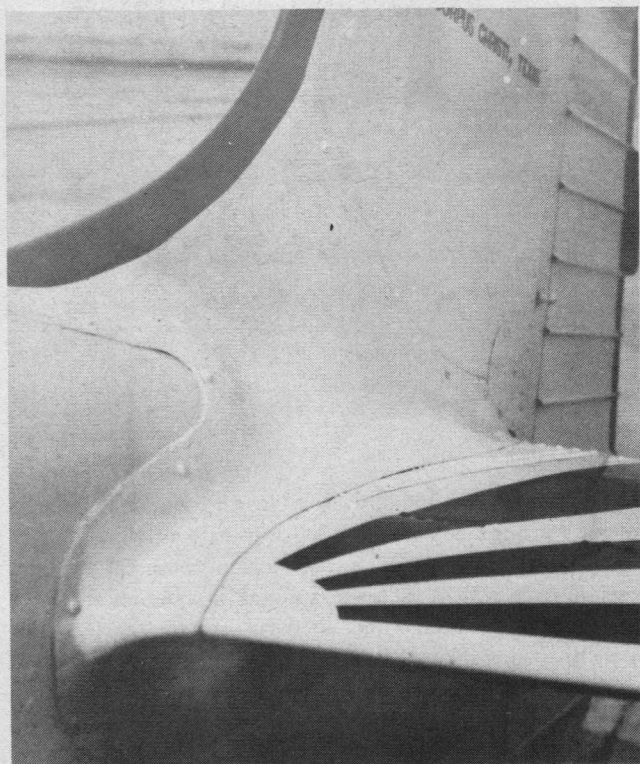
Cruise speed, mph: 110

Stall speed, mph: 55

Rate of climb, fpm: 1,000

Service ceiling, ft.: 16,500

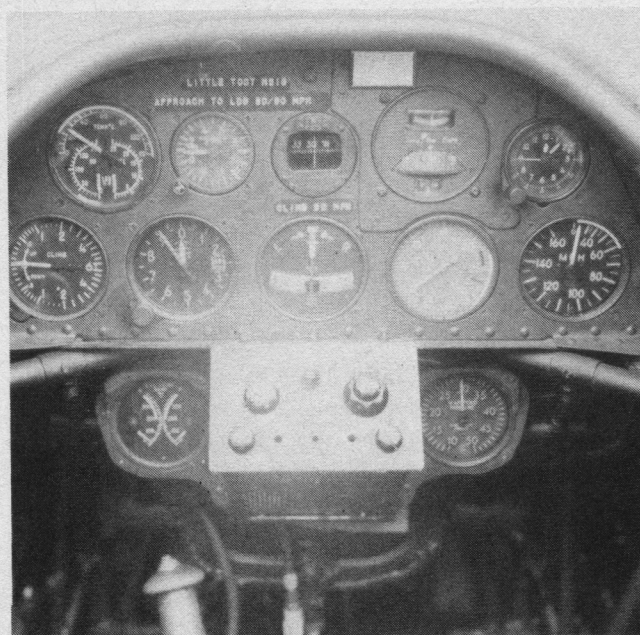
Range, st.mi.: 368



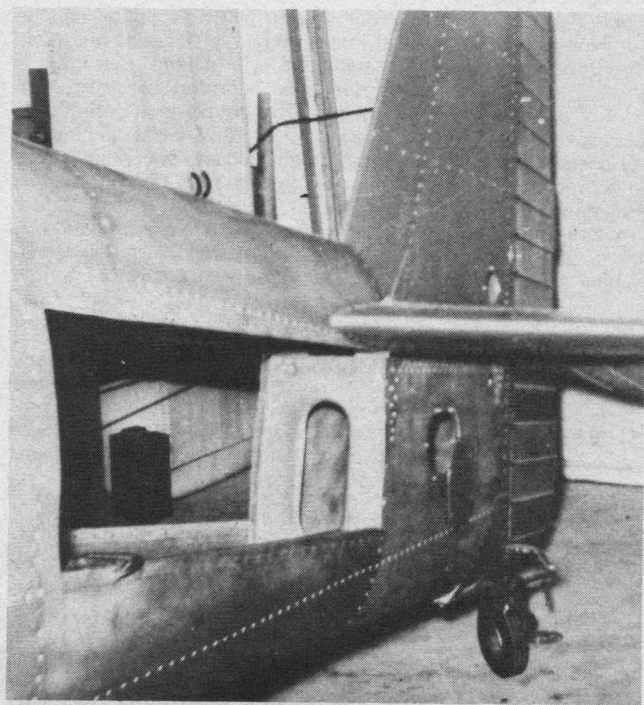
This Little Toot has metal fairing that cuts interference drag at stabilizer.



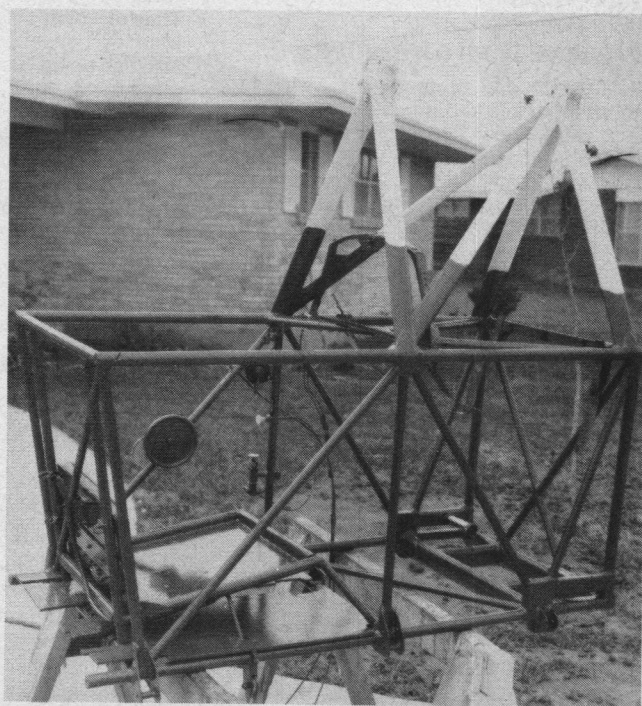
Profile of Little Toot shows its saucy stance, poised like a racehorse.



Roomy cockpit area of Little Toot is shown, with rugged tube construction.



Original Little Toot had metal monocoque tailcone and a sheet metal tail.



Heavy structure of cockpit framework lower spar carrythrough has 10-G strength.

GENERAL STORE

To order by mail simply send the price of the item plus any indicated shipping and handling charge in a check to Werner & Werner Corporation, Box 1136, Santa Monica, CA 90406. California residents please add 6% sales tax. Items shipped only to addresses in USA.



1 AIRMAN SUNGLASSES

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Survivor II \$29.95

Survivor IV \$99.95

No pilot should fly without one of these exhaustive survival kits. Each package contains provisions for shelter (tube tents and space blankets), food (3 days per person), first aid (plus water purification), water (by means of a solar still), fire (under all conditions), rescue signals, a 40-page survival manual and nearly every other imaginable necessity. Kits are for one, two or four persons. Each is packed in a waterproof container and ranges in weight from 2 3/4 lbs. to 3 1/4 lbs. to 15 lbs. They're a pilot's life insurance. Add \$2.50 shipping/handling for Survivor I & II; \$5.50 shipping/handling for Survivor IV.

5 RECORD-A-FLIGHT

This binder enables a pilot to record his daily operating and travel costs in addition to providing for monthly recaps and annual fixed expenses. This handy booklet also contains pages for other important data such as engine, prop and avionics serial numbers, plus insurance and registration information. 4" x 6" binder covered in leather-like black vinyl with gold lettering. Refills available. Just \$9.95 plus 50c for shipping and handling.

6 VICTORY FLYER SUNGLASSES

All the materials used in the American-made Victory Flyer Sunglasses are of exceptional quality. Their expertly-ground, gray-tinted lenses fight eye fatigue by blocking out harsh sunlight and providing distortion free vision. While they are sold in the best optical shops for up to \$30 per pair, they are offered at a special price of only \$15.95, plus \$1.00 for shipping costs. A hard carrying case is included. \$15.95

7 FEDERAN FLIGHT CASES

Sturdy and spacious, these professional-looking flight cases are covered with leather-like, scuff-resistant vinyl to provide the maximum in all weather protection and easy care. Each case has two full-width inside pockets, a molded plastic handle, brass trim and snap locks. There is more than enough room to carry all your pilot provisions.

14"x6 1/2"x11 1/2" \$16.95

16"x7 1/2"x12 1/2" \$19.95

Add \$1.50 for shipping/handling.

8 PRESCRIPTION SPORT GOGGLES

Your precise eye prescription can be built into a goggle, eliminating the need for awkward eye glasses. Our goggle provides clear, comfortable, distortion free vision. The double lens design acts like a storm window while eliminating fogging. Both lenses are made from impact resistant polycarbonate. All lenses meet or exceed federal safety requirements. Mail a copy of your eye glass prescription including P.D. measurement. Choose from two goggle frame colors: black or white.

STANDARD:

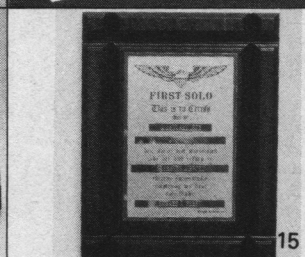
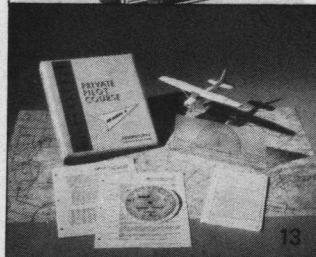
Comes complete with your choice of any two of the three interchangeable outer lens filters: Clear all purpose, Yellow-amber for overcast days, and Smoke-brown for bright days. \$49.95. Extra filters \$5.00 each.

POLARIZED:

Ideal for all climates, fog, snow or dust. Cuts glare and haze. Available in two filter colors: French-gray for bright days and Bronze for bright and cloudy days. \$59.95. Extra filters \$10.00 each.

SUPER-MATIC:

The outer lens color automatically adjusts to compensate for light to dark conditions. Similar to photogray lenses found in many expensive eye glasses. \$59.95. Extra filters \$10.00 each.



9 SUPER-FLITE 1 RADIO

This attractive portable radio features AC/DC operation, built-in battery charger, automatic frequency control, charging indicator light, earphone, vinyl case and hi-fidelity speaker. Six bands are covered: AM Broadcast, FM Broadcast, LF Aviation Weather Broadcasts, VHF Aviation Communications, Public Service Band, and VHF Weather Broadcasts. Size: 11"x7"x5". Add \$2.00 for postage and shipping costs. \$49.95.

10 PANEL POSTERS

Here's how to improve your flight training at home. These near-life-size full-color photographic prints of the instrument panels of two widely used trainers act as excellent teaching aids. They help the student visualize flight procedures and instrument locations as he pours over his text books. Measuring a large 24 x 36 inches, the posters display Cessna 150 or Piper Cherokee Arrow panels. They can also be used for wall decorations. Price \$3.95 each or \$2.95 each for orders of two or more.

11 LOCKHEED L-1011 COCKPIT PUZZLE

When you're finished with this jigsaw puzzle, you'll know the instrument panel of the L-1011 Tri-Stars as well as the pilots who fly them. Three hundred interlocking pieces fit together to form an 11"x17" full color reproduction of the flight deck in this newest and most celebrated of the jumbo jets. Add 50c for shipping costs. \$5.95

12 "T" SHIRTS

Wear one of these casual and comfortable T-shirts displaying either the "PIPER" logo or the "PRIVATE PILOT" emblem (for the latter designate either high or low wing). All emblems and logos are expertly printed on durable athletic shirts for long-lasting quality. Colors are white with red trim and graphics. Available in men's sizes: small, medium or large. \$6.95 each.

13 JEPPESEN GROUND TRAINING COURSES

Jeppesen promotes quick learning and lasting proficiency by offering the best instructional presentation, insuring retention and providing for easy review. The courses include all the essential information and materials you'll need. Each lesson segment is followed by practice questions with answers to test your grasp of the new material. You needn't buy anything more.

Mach I Private Pilot Course \$24.95

Approaches flight from the standpoints of basic theory, regulations and maneuvers. The complete kit includes a CR-1-type training computer and plotter, a flight maneuvers section, sectional chart, Federal Aviation Regulations and exam with critique.

Mach II Instrument Rating \$29.95

Instills all the knowledge and confidence required by this highly specialized dimension of aviation. The kit includes a CR-1-type computer, IFR proficiency hood, Federal Aviation Regulations, Jeppesen IFR chart, NOS en route chart, and final exam with critique.

Mach III Private Commercial \$29.95

Provides intensive instruction in airplane operation and performance, meteorology, communications, attitude instrument flying, high altitude operations, etc. Packet includes a CR-1-type computer and plotter, full-color sectional chart, Jeppesen Low Altitude Enroute Chart, Federal Aviation Regulations, and final exam with critique.

FLIGHT REVIEW PACK \$8.95

Included are two valuable training manuals that together provide the most practical and quick way to recall techniques and keep up with current methods. Private and Commercial pilots can prepare for their biennial flight review "currency" requirement or new pilots can prepare in advance for a flight with a review of maneuvers.

Staggerwing Beech

Piper Cherokee

14 OFFICIAL FLIGHT CAPS \$4.98

Be loyal to your plane by wearing one of these handsome caps with either Cessna 172, Piper Cherokee, or Beech Bonanza patches sewn on the crown. A strap in the back adjusts to fit all head sizes. Available in blue, black or yellow linen material. Extra patches with caps are 80c each. Patches sold alone are \$1.50 each. Add 50c for shipping.

15 FIRST SOLO TROPHY PLAQUE

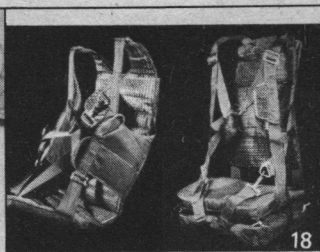
Pay tribute to your favorite pilot's first solo with this handsome, long-lasting plaque made from American black walnut and polished brass. It reads: FIRST SOLO — This is to certify that on (date), (Pilot's name) did, alone and unassisted take off and return to (airport of solo) thereby successfully completing his first solo flight (instructor's name) flight instructor. Be sure to enclose the necessary information. \$34.95 each for U.S. and Canadian orders. Also available in Private Pilot, Commercial Pilot and Flight Instructor plaques.

16 FULL-COLOR AIRCRAFT POSTERS

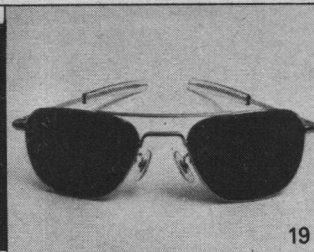
These large colorful posters feature some of the most popular planes of all time — Beech Bonanza, P-51 Mustang, Beech Staggerwing, Piper Cherokee and Cessna 172. You won't find these exclusive, beautiful posters anywhere else. They make an excellent gift for flying enthusiasts or use them for unique wall decorations. Black and white posters are also available of the Cessna 150 and the Piper Cherokee. Color 22"x34" posters \$2.95 each. Black and white 24"x36" posters \$1.25 each.



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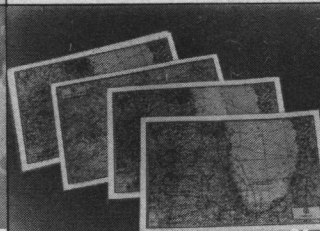
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PT-17



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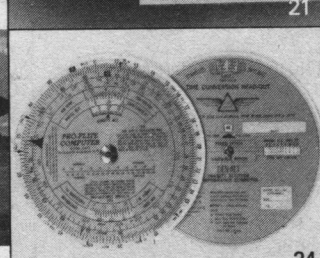


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Piper Cub

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24



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17 RAY-BAN SUNGLASSES \$22.00

Designed by Bausch and Lomb, these impact-resistant sunglasses are made to exacting specifications. The distortion free lenses are of the finest optical quality. Their neutral gray color protects against ultra-violet and infra-red rays. The frame is gold-colored metal with paddle-tipped temples. Case included. Add 50c for shipping/handling.

18 SAFETY-CHUTES

Progressive canopy construction and pack design make these parachutes dependable, safe and comfortable. They are the only steerable safety-chutes available with FAA TSO C23b approval. Each nylon canopy is fully steerable to avoid ground obstructions. Each features an efficient 22 1/2-foot conical design to optimize stability and yield an excellent ratio between bulk and descent rate — the same rate as that of a 28-foot flat circular chute. Two pack designs are available: the seat-type and the more modern chair type. Two canopy designs are offered: the limited for 150-mph planes and under, and the unlimited for planes with 150-mph plus capability. Prices: \$462 and up. Write for more information.

19 SKYMASTER SUNGLASSES

NASA chose these American Optical SkyMaster sunglasses for its astronauts. Their distortion free lenses are ground from heat-treated impact-resistant glass and colored with True-color tint. The result is protection from bright sunlight and glare without compromising cabin visibility and true color values. The 12K-gold frames are lightweight for comfort; thin so they won't obstruct vision; bendable so they won't break and can be adjusted to fit. Plastic case included. Suggested retail: \$23.50. Discounted price: \$19.95 plus 50c for shipping.

20 "ATC CLEARS" ALBUM \$9.95 CASSETTE \$11.95

This LP record teaches you to take down and respond to ATC clearances quickly and accurately. A professional controller begins slowly and builds up to the speed normally encountered at busy terminals. Side two has actual recorded clearances for practice. Includes instruction sheet and area chart. Add 50c for shipping/handling.

21 PLACE MATS 4 for \$6.00

Introduce an aviation decor to your breakfast or dinner table. These place mats are made from wipe-clean plastic and depict local flight charts. Choose from New York, Tampa/Miami, Chicago, Dallas/Ft. Worth, Los Angeles/San Diego, or San Francisco/Sacramento. Extra mats can be purchased for \$1.50 each. Add 50c for shipping/handling.

22 DELUXE FLYING GLOVES \$12.95

Soft, yet snug fitting. These pilot gloves offer better grip, warmth and perspiration absorption without interfering with the manipulation of instrument panel switches and controls. Hand-crafted from quality thin-out imported capeskin leather, they are available in brown or black, sizes: S, M, L, XL. Add 50c for shipping/handling.

23 TRAINERS OF THE FORTIES

If you earned your wings in one of these classic planes, or if you simply enjoy collecting nostalgic aircraft prints, you'll want one or more of these handsome lithographs. Ideal for framing, each print measures 19 1/4 x 14 1/4 inches including the self-matte borders. Sharp detail and high quality stock make them superb wall decorations for home or office. Available are the PT-19, PT-17, BT-13, AT-6 and Piper Cub. Price: \$2.50 each, all five for \$11.00. Postpaid.

24 PRO-FLITE COMPUTER \$9.95

This one is different! And in a special way. Not only does it have the usual computer calculations on the front side for speed and altitude and other standard conversions, on the reverse side it has the famous DEN-ALT density and altitude performance computer. This is very important for making safe takeoffs and landings with loads and varying temperatures and altitudes. Computer works for both fixed-pitch and variable pitch or constant speed propellers. \$9.95

25 FLIGHT INSTRUCTION ALBUM \$12.50

This three-record album is a comprehensive, easy-to-understand guide to elementary flight training. The clearly explained lessons cover: the effect of controls, straight and level flight, use of trim tabs, turns, banks, climbs, glides, slow flight, stalls, steep turns, load factors, takeoffs, landings, crosswinds, and emergency procedures. An excellent way to begin learning to fly. Add 50c for shipping/handling.

26 ALL-LEATHER ARMY AIR CORPS FLIGHT JACKET

This is your opportunity to own an exact copy of the jacket worn by WWII Army Air Corps pilots.

No-nonsense pilots find that this jacket more than lives up to its reputation as a rugged, warm garment with classic styling.

Made from genuine steerhide, the Air Corps jacket holds its shape and retains its attractive appearance even after years of abuse. It can only improve with age. Cozy quilted lining provides superb insulation. Knit cuffs and waistband of 100%



wool plus snapfly over the zipper-keeps cold air out and warm air in. Jacket comes with a removable fur collar. Under arm gussets with air vents allow freedom of movement and air flow.

Roomy two-way patch pockets with flaps snap shut for safe keeping. For easy access, a map pocket and a pen and pencil pocket are located on the upper left sleeve. Shoulder epaulets follow the original styling.

ORDER NOW! This enviable flight jacket is in great demand. Available in dark brown only. Sizes 36-46: \$108. Sizes 48-50: \$118. Satisfaction Guaranteed.

OUR SECOND FLIGHT JACKET

This authentic jacket is also made from genuine steerhide and has all the distinctive features of the other style of flight jacket minus the removable fur collar, underarm gussets and air vents, and map, pen and pencil pockets. Available in dark brown only. Sizes 34-46 \$98, sizes 48-50 \$108. Satisfaction Guaranteed. For both jackets only U.S. order. California residents add 6% sales tax.

27 PILLOWS

Featuring a colorful montage of famous antique aircraft. Perfect for sleepy passengers in your airplane or automobile. A decorative addition to your den, bar or game room. Choice of white or beige background. Sizes: small \$5.95, medium \$9.95, or large \$14.95.

28 MEN'S TIES

Guaranteed not to go unnoticed. These ties, displaying the same brightly-colored aircraft pattern, will add a zesty touch to any sport outfit. Give one to your favorite pilot. Available with either a white or beige background. \$6.95

29 HEAD SCARF

Hold your hair in place at windy airports and keep prop wash out of your coiffure while staying in character with your aviation surroundings. Available with either a white or beige background. \$6.95.

30 AERO 3-D MAPS

Aero Relief Maps give a preview in miniature of the sight you'll see from aloft. Here are the mountains, uplands, plateaus, plains, valleys, rivers, cities, states, and countries you can plan your future flights around. On the California map, airports are clearly marked.

All these maps are printed in rich, full colors on wipe-clean heavy-gauge vinyl with a golden-olive steel frame, heavy cardboard backing.

U.S. MAP	65"x43" (NR1)	\$85.00
CALIF. MAP	41"x47" (NR105)	\$80.00
WORLD MAP	62"x43" (NR98)	\$85.00

31 GLASSWARE FOR PILOTS

1. Trophy Glasses

Available in sets of four, these 14 oz. executive tumblers can be ordered in any one of three personalized formats. A set can be custom decorated to picture your own type of airplane with its N-number. A set can be created to duplicate your solo certificate. Or, a set can be made to proudly bear your name and pilot certificate number. Price: \$12.95 per set plus \$1.50 for shipping/handling.

2. IFR Night Landing

Through a cockpit window pictured on the near side of the glass can be seen the lights of a landing strip on the opposite inside of the glass. All detailing is done in black enamel. A unique conversation piece. Price: \$12.95 per set plus \$1.50 for shipping/handling.

3. Matching Decanter

Golden replicas of antique aircraft decorate this 25 oz. mixing and serving decanter which complements all the other glassware items. Each decanter features a glass stirring rod and an easy-pour spout. Price: \$7.50 each plus \$1 for shipping/handling.

4. Aviation Ashtray

Whether used to complete a set or stand alone, this magnificent ashtray is a handsome addition to any room. It too is ornamented with a montage of antique aircraft in 22K gold and is made from heavy bottom crystal. Size is a full six inches across. Price: \$6.50 plus \$1 for shipping/handling.

32 OFFICIAL FLIGHT BAGS \$5.95

Rugged is the word for these deluxe flight bags. Made from nylon with vinyl laminated backing and sewn with nylon thread throughout, they feature reinforced handles, a zip opening, side pocket and bell studs on their masonite bottoms. They are available with Beech, Piper, Cessna or Mooney lettering. Colors are brown, navy, red or black. Add 50c for shipping/handling.

33 PILOT IDENTIFIER \$4.95

Popular and useful. Auto license plate frame that reads FAA LICENSED PILOT. Promotes General Aviation. Every pilot should have one. Sturdy and durable. Postpaid. \$4.95

34 PORTABLE RADIO-CASSETTE RECORDER

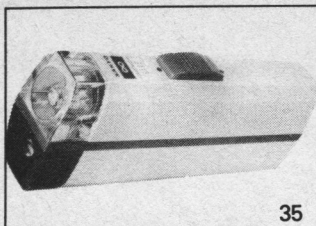
This exceptionally fine radio combines the features of an aviation radio, including all the important broadcast bands, with those of a built-in tape recorder. GE's electronic circuitry and powerful output, in addition to fine tuning and squelch control, yields superb reception and sound quality. Aviation tower, traffic control, and aircraft frequency receptions are from 108 to 136 MHz.

The tape recorder allows pilots to record any broadcasts on standard tape cassettes for playback on this tape-radio or any other tape recorder. The cord microphone can be used to add your own voice to tapes. A second microphone is built in to the face of the unit.

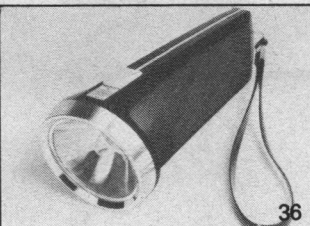
The radio-recorder operates on either flashlight batteries or plug in cords. An adapter is available which enables the unit to be attached to electric panel cigarette lighters.

Frequencies in addition to aircraft are standard AM and FM and public service band (150 to 174 MHz). Local federal weather bureau transcribed NLAA VHF weather broadcasts can also be tuned in.

This fine radio measures 12 1/4"x8 1/2"x3 1/2" and costs \$150 plus \$3 for shipping and handling. Order your GE radio-cassette recorder today. \$150.00



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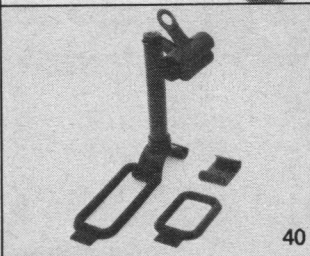
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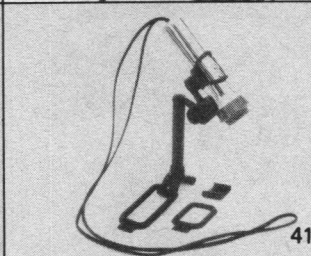
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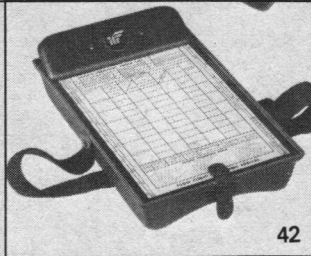
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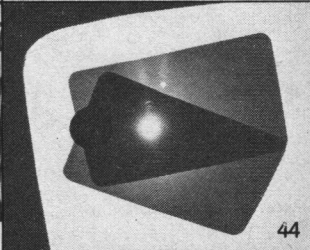
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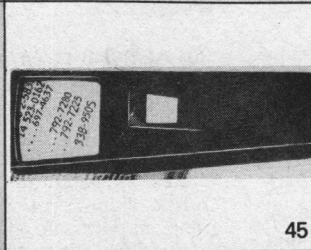
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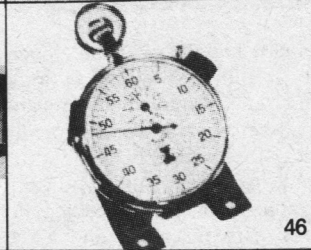
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35 RECHARGEABLE FLASHLIGHT

The beauty of this miniature Sanyo flashlight is that it is powered by nickel-cadmium rechargeable batteries. They can be brought back to full power hundreds of times by plugging into an AC electrical outlet. When fully charged, the flashlight delivers approximately 80 minutes of power, through either its red or white light. \$1.00 for shipping. \$8.95

36 RECHARGEABLE SEARCHLIGHT

Extra power and weatherproofing are the added features of this Sanyo flashlight. It is powered by Cadnica rechargeable batteries that deliver full power until they are completely exhausted — approximately 70 minutes. Its beam will outshine the best two-cell regular flashlight. The Sanyo flashlight is fitted with a handy carrying strap and a built-in magnet for clinging to metal surfaces. Keep one on hand in your plane, you'll need it. Add \$1.00 for shipping/handling. \$14.95

37 EMERGENCY OXYGEN UNITS

Both units provide the fastest and most effective treatment due to their simple operation in an emergency situation. Simply start the oxygen flow by means of a lever, then apply the face mask. The proper flow of oxygen is automatically regulated — six liters per minute for 34 minutes. The lightweight, 9-pound, Mark II comes complete with a sturdy vinyl carrying case, a single refillable oxygen tank, face mask with rebreather bag, and a refilling adapter. Size 3½"x7"x15¼". The Mark IV includes the same equipment as the Mark II, plus an extra complete inhalation unit (double tanks). All oxygen units are fitted with a fusible fireplug for fire protection. Price includes shipping/handling. Satisfaction guaranteed.

Mark II \$129.50

Mark IV \$199.50

38 HOODWINK

There's no peeking with the Hoodwink IFR flight hood. Its unique binocular design provides the best view restriction while its light weight will not cause fatigue if worn like glasses, folds flat in its carrying case, and is fully adjustable. It will not interfere with the use of headsets. Construction is from a heavy, plastic coated cover stock. Hoodwink makes all other cumbersome flight hoods obsolete. Add \$1.00 for shipping/handling. Absolute satisfaction guaranteed. \$5.95

39 BRIGHTEST HAND SPOTLIGHT

Twin H-3 Quartz Halogen bulbs project dual beams that converge to form a single one-mile-plus beam. Rated at 360,000 candlepower, the "Ultra Light" draws only 5 amps and is fitted with a heavy-duty 15-foot power cord that plugs into any 12-volt cigarette lighter. The Quartz bulbs are three-times more powerful than sealed beams yet last 2½-times longer. Other features include a finger-tip switch and pistol-grip handle, plus a specially vented highly-polished reflector. \$49.95

40 CLIP-IT \$3.75

This indispensable clip is designed to hold approach charts, sectionals, checklists, etc. in the plain view of a pilot. Easily adaptable, it fits the yoke of most light aircraft. Color is flat, non-reflecting, black. Add 50c for shipping/handling.

41 CLIP-LITE \$6.50

This useful chart clip comes complete with its own self-contained light source. A small flashlight either attaches to the clip itself, to illuminate approach charts, checklists, etc., or can be hung around the neck by means of a cord and used separately. Fits the yoke of most light aircraft. Battery not included. Add 50c for shipping/handling.

42 PILOT'S DAYBOARD \$15.95

Here is a versatile clipboard that can be used for inflight computations, notes, charts, etc. An adjustable elastic band secure the clipboard to the pilot's leg to provide a stable writing surface. Included are a log pad, pen and WAC/sectional scales. Essential for pilots. Add 50c for shipping/handling.

43 KNEEBOARD \$6.99

This special pilot aid is much more than a simple clipboard. It comes complete with a pre-flight checklist, flight log, plus position reporting and flight plan sequences. Its hinged lid opens up to a compartment for spare pencils, forms and other essentials. A Velcro fastener straps the dayboard to your leg to form a steady writing platform. Truly, a pilot's best friend. Add \$1.00 for shipping.

44 SUN SCREEN FILTER \$3.95

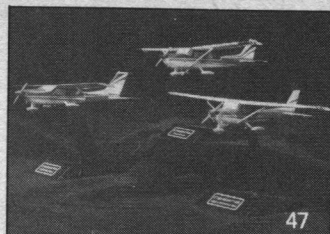
This glare shield is made up of two tinted 3"x5" plastic rectangles that pivot on a single suction cup attachment. Can be used to block out direct sunlight through cabin glass or as an instrument cover for students. Add 50c for shipping.

45 FLASHLIGHT/MAGNIFIER \$3.95

When available light is poor, this small flashlight/magnifier is perfect for reading charts, maps, or fine print anywhere. Its lens provides 3X magnification while a tiny G.E. magnifying bulb illuminates the subject. Two pen-lite batteries are included. Add 50c for shipping/handling.

46 STURDY STOPWATCH HOLDER

Mount your stopwatch on any clipboard with this convenient all-metal holder. Designed to fit any stopwatch except those with slide controls. Add 50c for shipping/handling. \$2.50



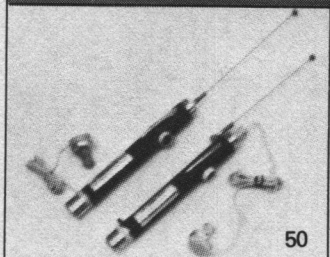
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47 AIRPLANE MODELS

CESSNA MODELS

Each high-quality plastic model comes completely assembled with a supporting pedestal. Wing span is 8.2" for the 150; 9.1" for the Skyhawk, and 8.9" for the Cardinal. These models are available in overall white with red, blue, green or yellow. Each has a decal set for the owner's aircraft registration number. Models available: 1975 150 (red, green, yellow, blue); Aerobat; 1975 Skyhawk (red, green, yellow, blue); 1975 Cardinal (red, green, yellow, blue). Please add \$2.00 for shipping/handling. \$16.95

Piper Cherokee, Beechcraft Bonanza

All models in this 1/48 scale light plane series are well detailed inside and out. Each kit includes decals of popular markings and adjustable stand. Wing span is approximately 8 inches. \$2.70 each.

Boeing 727; Douglas DC-3, DC-10; Lockheed L-1011

All models in this series are approximately 1/100 scale and range from 12 (727) to 29 (747) inches in length. Each includes a sturdy display stand and decals to enhance authenticity. All parts are pre-colored, no painting necessary. Prices: 727 — \$6.55, 747 — \$19.95, DC-10 — \$12.95, DC-3 \$3.45, L-1011 — \$12.95,

Air Giants

B-1 Bomber: Designed to deter war into the 21st century and replace the B-52. 1/144 scale, over 12 1/2" long. \$6.55.

Spruce Goose: Still the world's largest airplane, Howard Hughes built this seaplane at a cost of \$18 million. 1/200 scale, 19" wing span. \$6.55.

Dornier DO-X: The largest aircraft in the world in 1929 and the only aircraft known to have had 12 engines. 1/144 scale, 13-1/8" wing span. \$7.95.

Guppy 201: The world's most unusual transport aircraft designed by Aero Spacelines. 1/144 scale, 13" wing span. \$7.65.

To order any of these models add 50c per model for shipping and handling.

48 VINYL AIRCRAFT COVERS

WINDOW COVERS

All window covers are custom tailored to fit any make of aircraft and are available in either windshield or full windshield/side-window models. Write for more specific information.

WHEEL COVERS

Protect your plane's tires and double the life of the brake pucks by limiting disc corrosion. Either \$10.95 for main gear set, or \$18.95 for all three gear.

DUST PLUGS

Inhibit the dust from entering your plane's vent holes but also keep out ice, snow, water and bird nests. Plugs come complete with fluorescent "caution" flags. Sold in sets of two for \$12.95.

RUDDER LOCK

Secure your plane's tail control surfaces with this rudder lock designed to fit any conventional tail configuration. Our rudder lock provides the best protection available. Just \$26.95 complete with "caution" flag.

PROP PROTECTORS

Shield your propeller blades against costly corrosion, sand storms, freezing rain, etc. These prop covers are made from weather-resistant vinyl material. Two-blade: \$15.95. Three-blade: \$22.95.

TRAVEL CHOCKS SET

Chocks are made from fiberglass and fit all tire sizes. May be purchased separately or in a kit which includes steel tie down cable and stakes. Set of four chocks: \$6.95. Complete kit: \$15.95.

PITOT TUBE PROTECTORS

Prevent foreign matter and dampness from fouling your plane's pitot tube whether your plane is stored in a hangar or tied down out-of-doors. Only \$3.95.

49 WIND SOCK \$14.95

The sock on this miniature version of the real thing measures 14" long and 4" in diameter. It is made from durable flame orange cotton material. The two-foot high stand has a hardened steel shaft with bronze oil light bearings and cast aluminum wind directions. Add \$2.00 for shipping/handling.

50 SKY SPY \$24.95

SKY SPY DELUXE \$29.95

Both pen-size radio receivers need no auxiliary equipment to pick up tower transmissions from a five-mile radius or aircraft transmissions from a 25-mile radius. The standard Sky Spy includes batteries, a stationary antenna and magnetic earphone. Sky Spy Deluxe comes complete with batteries, folding antenna, removable magnetic earphone, automatic on/off, and vinyl carrying case with pockets for spare batteries and earphone. For listening with both ears and eliminating external noise, a stethoscope accessory is available for only \$2.95. Add \$1.00 for shipping/handling.

51 DAVIS RANGE FINDER \$27.95

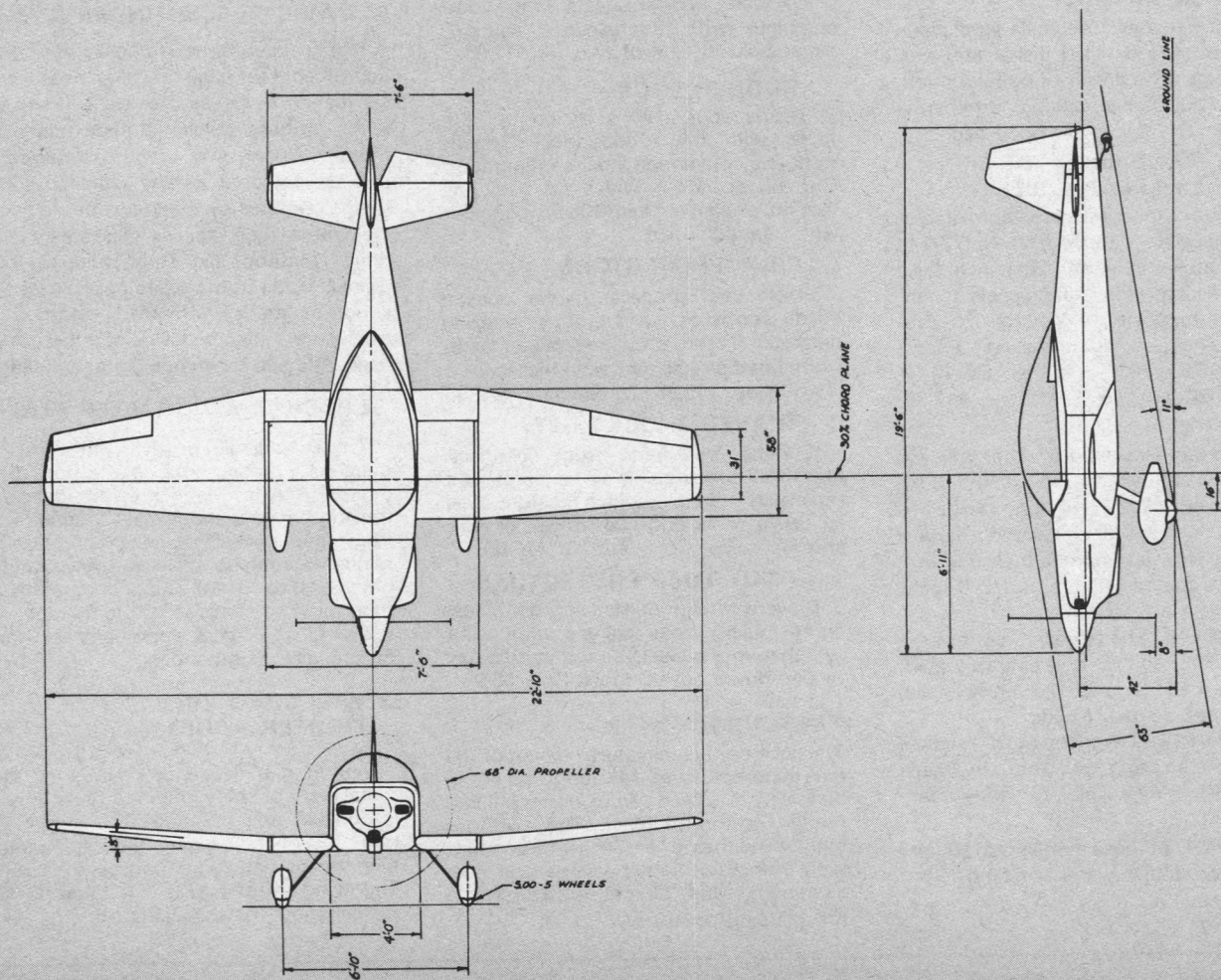
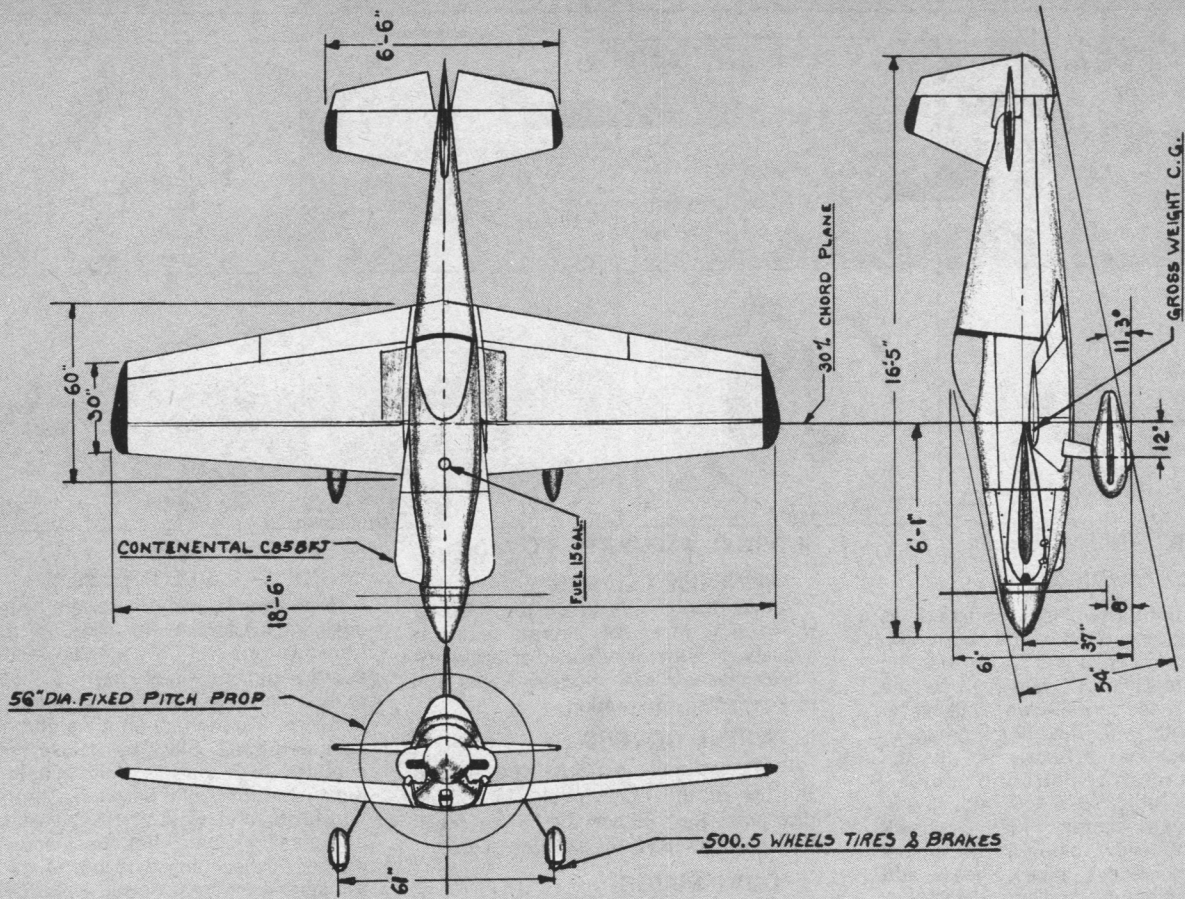
A highly accurate, scientifically designed instrument that measures distances from six feet to as far as the eye can see in yards, statute miles, nautical miles or metrics. Changes in range of 1 percent can be detected at any distance. The gauge operates by the stadiametric principle rather than the less accurate coincidence method. No stabilization is required. Made from high impact plastic, it is non-magnetic, waterproof, and corrosion proof. A dandy device of a thousand uses. Add 50c for shipping and handling.

52 POCKET WIND METER \$6.95

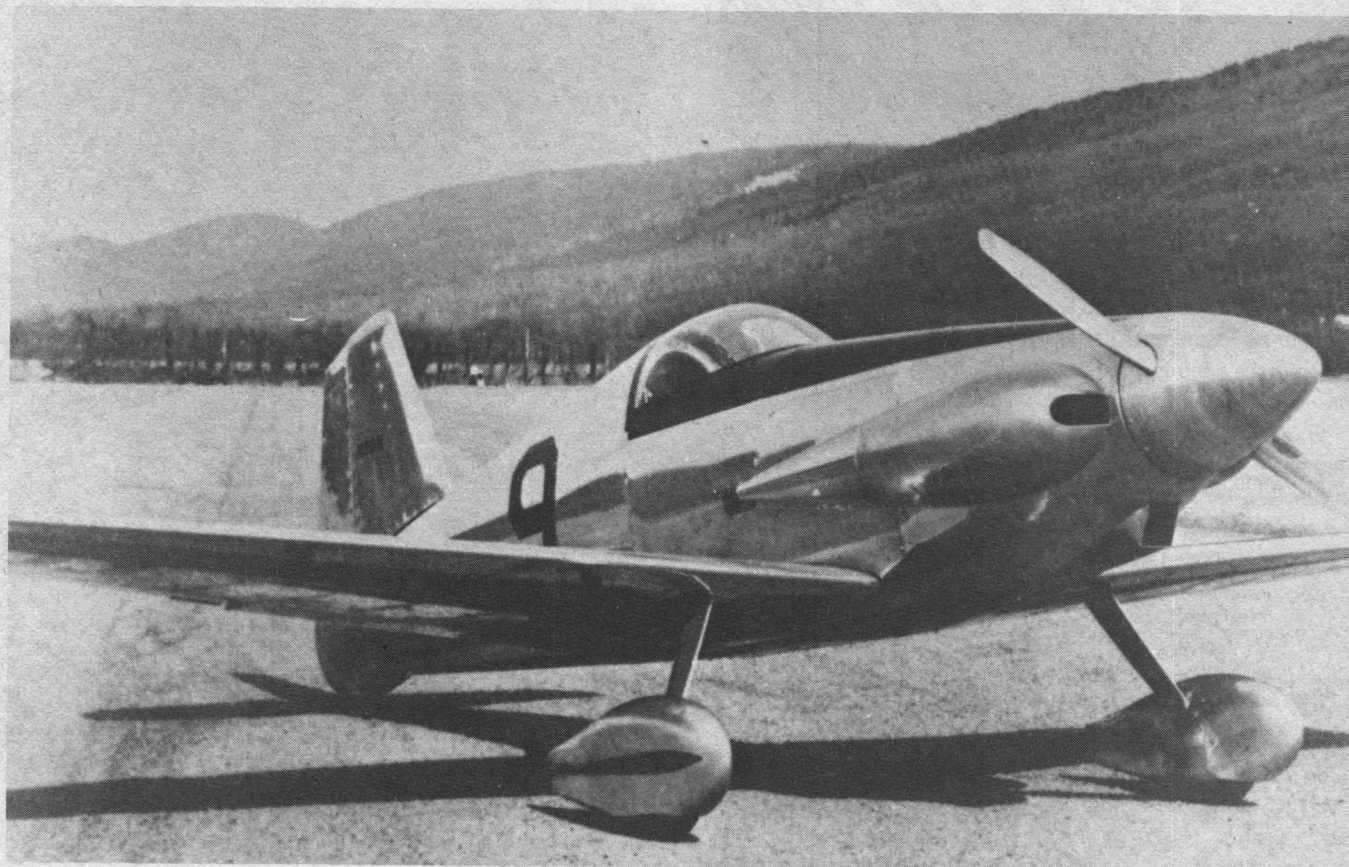
This is a reliable, precise wind velocity gauge at a gadget price. Made from die-molded Acrylic Plastic with few delicate moving parts, it should last indefinitely. The meter delivers accuracy of plus or minus 1/2 mph when measuring winds between 0 to 10 mph and plus or minus 3 mph for winds between 10 to 66 mph. A useful piece of pilot paraphernalia. Add 50c for shipping/handling.

53 WWI SPAD XIII FIGHTER RADIO

Featuring a solid-state radio, its all-metal body of shiny gold and silver finish is detailed to perfection. The model is mounted on an elegant base complete with metal nameplate for personalized engraving. Size: 8"x7 1/4"x4". Add \$3.00 for shipping costs. \$29.95.



The Bushby Mustangs



IF THERE ARE any of you out there in readerland who have hesitated to start a homebuilt because you didn't think you could get the speed and performance you wanted, drop a line to Bushby Aircraft, Inc., 848 Westwood Drive, Glenwood, Ill. 60425.

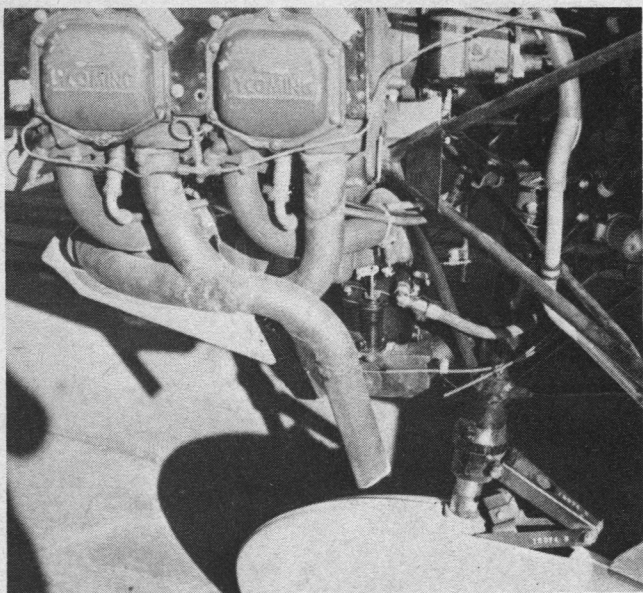
They'll solve your problems with a homebuilt they list as good for 230 mph top, 200 cruise, 450-foot takeoff, 2,500 fpm climb rate and a range of 400 miles. If you'd like a bit more room and two seats, you'll have to be satisfied with 194 top, 180 cruise, an extra 150 feet of takeoff distance and a mere 1,800 fpm of climb.

The aircraft that do this are the Midget Mustang, a single-seat bomb with a Lyc 125-hp engine (or a Continental 85 hp with slightly less performance), and the trim Mustang

II two-seater with up to 160 hp. The former is a frisky tail-dragger, and the latter can be built with conventional or tri gear.

Both are all-metal aircraft designed for ultra-simple assembly. No jigs are required for the II, and only two simple wood jigs for the Midget. Bushby can supply components, or even full kits, which eliminate virtually all the bending. Bushby reports that about 1,000 manhours are required to assemble the Midget, and cost can be kept to about \$1,200 not counting the engine if you're careful in buying materials.

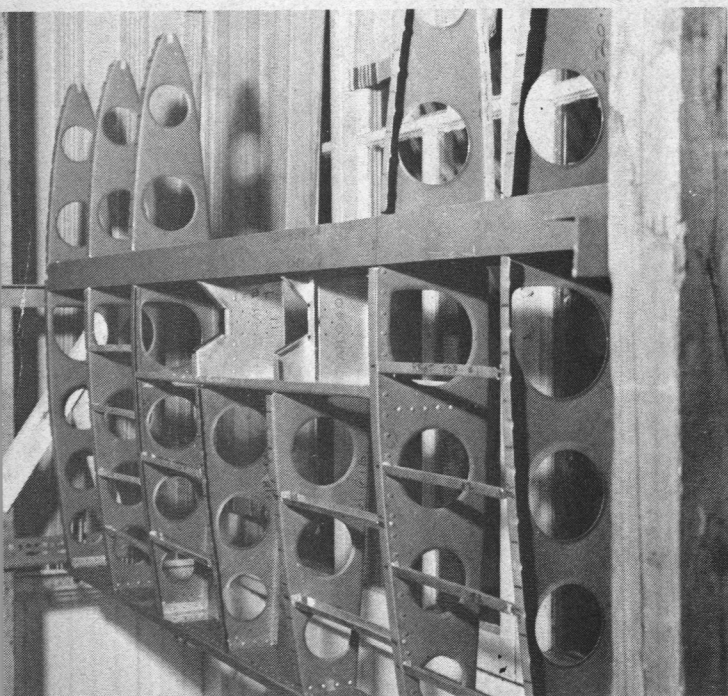
The II was developed as a cross-country and sports plane, and based on some 15 years of experience in building Midget Mustangs. It has a 40-inch-wide cabin, seats adjustable



Details of engine mount, nose gear and Lycoming O-290 installation on Bob Bushby's prototype Mustang II.

through four inches, and enough panel to accommodate full IFR gear including dual nav/com. At a gross of 1,450 pounds it is stressed for 6 Gs, and the sport model (without electrical system and similar frills) at 1,250 gross is good for 9 Gs, so the sport is adequate for aerobatics. The Midget also is good for 9 Gs.

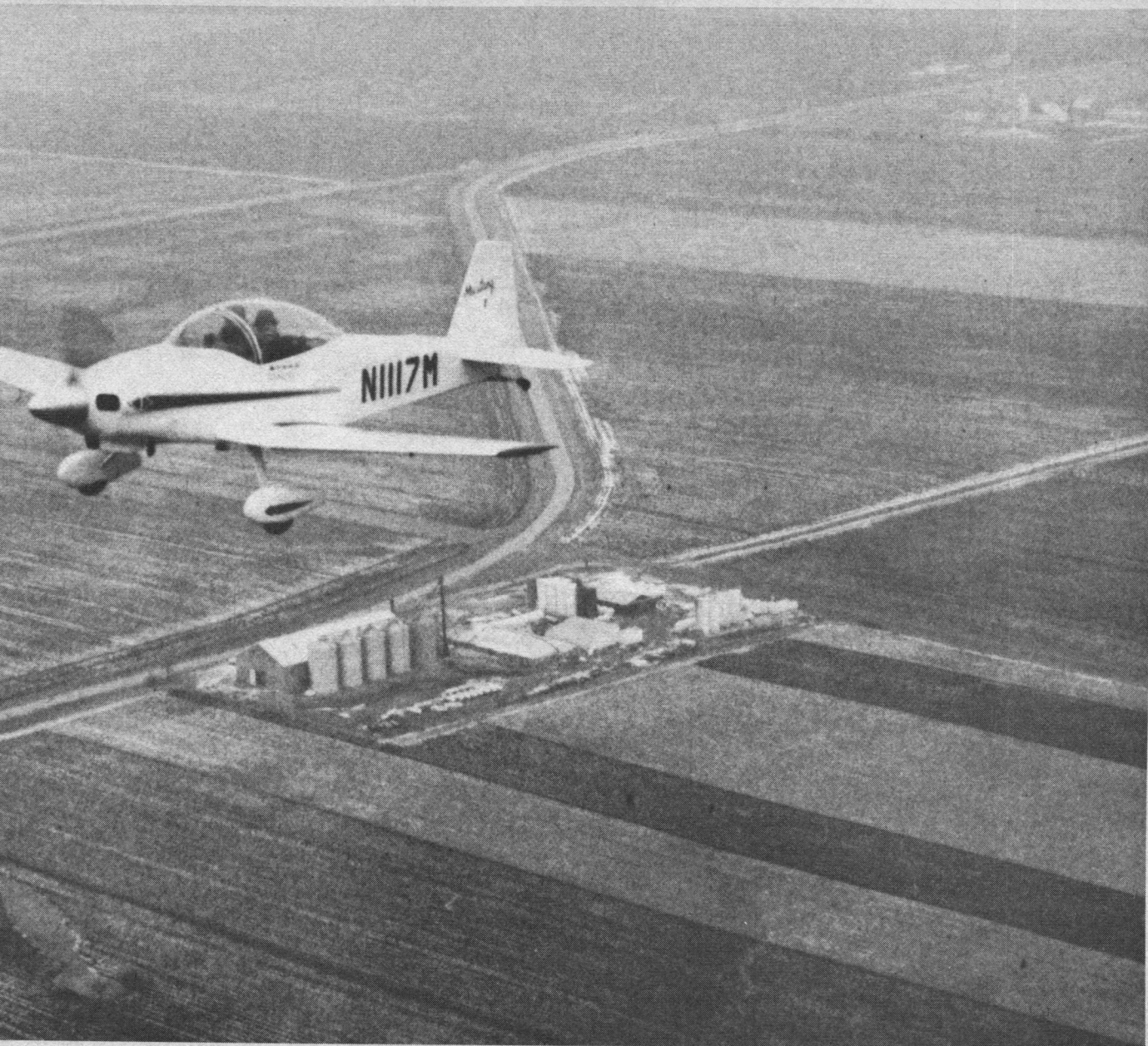
Plans for either airplane include a 60-page construction manual with more than 45 photos and illustrations of detail areas. The manual was written for the Midget, but is useful for the II and also is available separately. Plans cost \$75 for the Midget and \$125 for the Mustang II. Information packets are \$2 per plane. ●



Mustang II wing center section shows typical metal fabrication common to it and long-popular Midget Mustang.



Mustang II two-seater makes a fine cross-country airplane, and stressed to 9 Gs also can be flown aerobatically.



Performance and Specifications

	Midget Mustang	Mustang II
Wing span:	18'6"	22'10"
Length:	16'5"	19'6"
Height:	4'6"	5'3"
Engine:	Lyc 125-hp	Lyc 160-hp
Wing area, sq.ft.:	68	95.5
Gross weight, lbs.:	900	1,500
Empty weight, lbs.:	580	925
Wing loading, lbs./sq.ft.:	13.2	15.7
Power loading, lbs./hp:	7.2	9.3
Fuel capacity, gals.:	15	25
Top speed:	230	194
Cruise speed, mph:	200	180
Stall speed (flaps) mph:	60	62
Rate of climb, fpm:	2,000	1,600
Takeoff distance, ft.:	400	600
Cruising range, miles:	400	425



Meet The VP-1

THE BUG TO build an airplane comes in as many shapes as the airplanes people can build when they get it. But one shape it almost always comes in is the bug for economy, and for a minimum of both construction cost and construction time it is hard to beat the bug they call the VP-1.

Designer W.S. Evans of La Jolla, Calif., is a design specialist with Convair, and when he set about creating the VP-1 the number one target was a safe, easy-to-fly airplane with a maximum of construction simplicity. Evans reasoned that most potential builders who shy away from constructing their own airplanes do so because they consider the job too complex, and he wanted an airplane that anyone could build with a minimum of time, tools and talent.

He got one. It took two years of design effort and a stack of paperwork a couple of feet high, but the VP-1 emerged from the process about as close to being a minimum airplane as any design has yet come.

The fuselage is a simple plywood box with aircraft spruce longerons at all four corners. There are only three bulkheads: one is the firewall, with the Volkswagen engine bolted directly to it without benefit of mounts. To handle the strain it is sawn from $\frac{3}{4}$ inch exterior grade plywood. The other two bulkheads are built up of spruce, fir and plywood. They form the cockpit, and both wing spars and bracing struts bolt to them.

The rear fuselage employs no diagonal members: the stressed skin carries shear loads and also distributes torsion loads through differential bending of the side, top and bottom panels. The tail cone ends in a wood stern post.

Wing construction also is planned for absolute simplicity. The two spars in each panel are planks of aircraft spruce, and ribs are gang-sawn from plywood. Leading and trailing edges are shaped from clear white pine. Internal loads are handled by drag wires of $\frac{3}{32}$ inch aircraft cable, but compression struts are less conventional: they are plain birch dowels $\frac{7}{8}$ inch in diameter, with a recess drilled into each end to fit tightly over fiber nuts on the rear face of the front spar and the front face of the rear spar. When they are in place neither end can slide off its anchor, and all it can do is sit there and soak up compression loads.

The wings are fabric covered, and each spar is attached to its respective fuselage bulkhead by a single bolt, as is the inboard end of each flying strut. The outboard strut ends attach to aluminum bushings pressed into the spar, which is

only 11 feet long and has no taper or bevel — just a plain, flat plank. There are no flaps, and the ailerons eye-bolt directly to the rear spar.

Both of the fabric covered tail surfaces of the VP-1 are all-flying, and while this has become fairly common practice for horizontal surfaces it is much less common for the vertical surface. What would you call a combination vertical stabilizer and rudder — a ruddalizer? Whatever it is called, it pivots on a two-inch aluminum tube spar which rotates in bushings in the top and bottom skin of the aft fuselage. The tube is carried below the fuselage to mount the bellcrank for the steerable tail wheel. An even simpler method was selected to mount the horizontal tail: three eyebolts in the sternpost and three more on the stabilator spar, which is a constant-section box spar. A $\frac{3}{8}$ inch steel bolt passes through the lot and presto! the stabilator is hung.

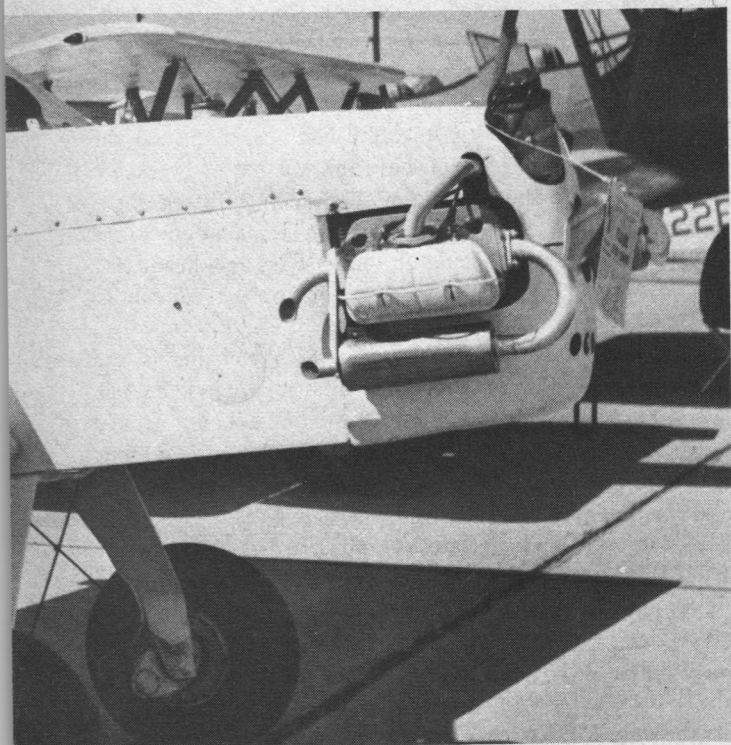
On the other end of the VP-1, things are not much more complicated. Any stock VW engine from 1200 to 1600 cc can be used. On the prototype the engine has not been reworked internally. The distributor was replaced with a Vertex magneto which fits the same hole, and a carburetor heat box and muff were fabricated and installed. The fan pulley on the front end was replaced with a Rollason prop hub, and the flywheel on the other end of the crank was cut away except for its hub. With the addition of an oil bypass fitting and a little minor surgery on the air intake and exhaust pipes, the powerplant is ready to hang on the forward bulkhead. Ray Hegy of Marfa, Tex., made the prop, and Evans recommends 54 inch diameter with 33 inch pitch.

About the only structural part which remains is the landing gear, and Evans went the simplicity route here, too. The main gear is one piece of 24ST3 aluminum, bent to shape and fastened to the fuselage through the lower longerons with four bolts. An X-brace of steel cables tends to keep the legs from spreading on touchdown as a Cessna-type gear would do, and landing loads are absorbed instead by the tires. They are 6:00X6, which is practically balloon-oversize for an aircraft of the VP-1's weight and dimensions.

Welding is an expensive and complex bugaboo on some homebuilts, so Evans virtually eliminated it on the VP-1. The flying struts, stabilator horn and control stick assembly are the only parts in the entire airplane requiring welding. What holds this one together is not melted metal, but Aerolite glue, a simple powder-and-catalyst product which



*Want to feel complete solitude in the sky?
Take off in a VP-1 and the whole sky is yours!*



*Tiny VW powerplant is no great gas eater
compared to other ships parked on the line.*

can produce bonds as strong as the wood it joins.

Add a fiberglass fuel tank between engine and instrument panel, a few control cables and a few instruments, and there you have it. No frills, no concession to beauty and no record-breaking performance, but an undeniably simple machine to build.

For confirmation, come with us to the garage of Anton Emmerton at Crown Valley Highlands, in the Laguna hills south of Los Angeles. His VP-1 is something of an international incident: Emmerton and his charming wife Anna are English, and although they make their home in California he's European sales manager of a firm which builds boats in Hong Kong and Singapore. Holder of a U.S. private pilot's license since the summer of 1969, Emmerton had never built anything, not even a boat or a kitchen cabinet, with his own hands.

"I was an absolute amateur when I started this project," he confesses. "I knew nothing at all about carpentry, much less about airplane building." But the first time he saw the VP-1 he decided it was the plane for him, and he sent for the plans.

With frequent delays for business travel, Emmerton estimates that he has spent about two months of evening and weekend spare time getting the fuselage to the stage shown in the construction photos. "All those evening sessions usually don't amount to much more than about two hours or so," he notes, "but the VP-1 goes together rapidly. It must be the greatest little bomb of all if you're new to



homebuilding."

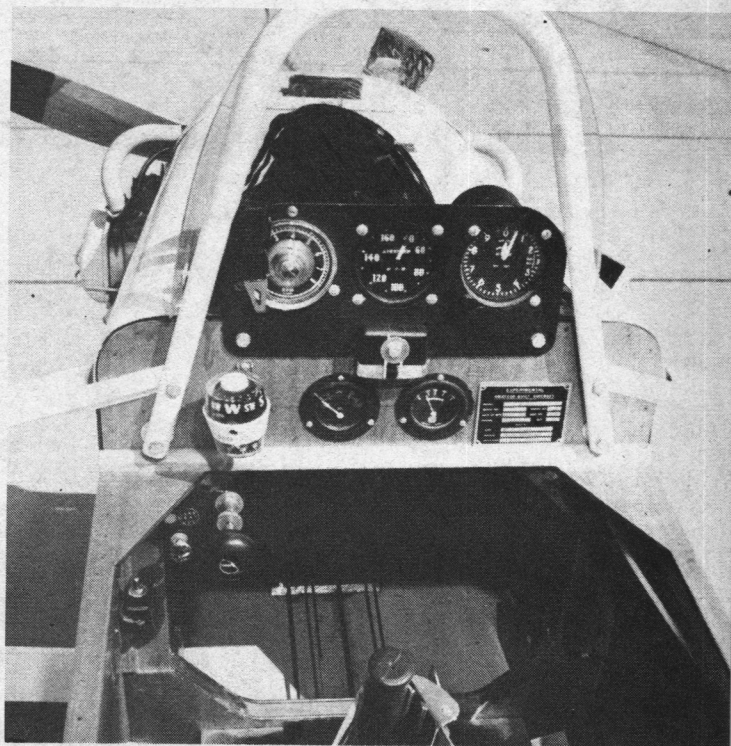
He has no power tools at all, not even a hand drill or sander, and since his goal is to complete and fly the VP-1 for a total expenditure under \$1,000 (plans included) he doesn't expect to buy any.

Emmertson started his project by making a jig table of half-inch plywood. He then began fabrication of the built-up bulkheads at the front and back of the cockpit section which serve as wing spar and flying strut attach points. One bulkhead was built and thrown away because it was the first piece of woodwork he had ever done, and it didn't come out right.

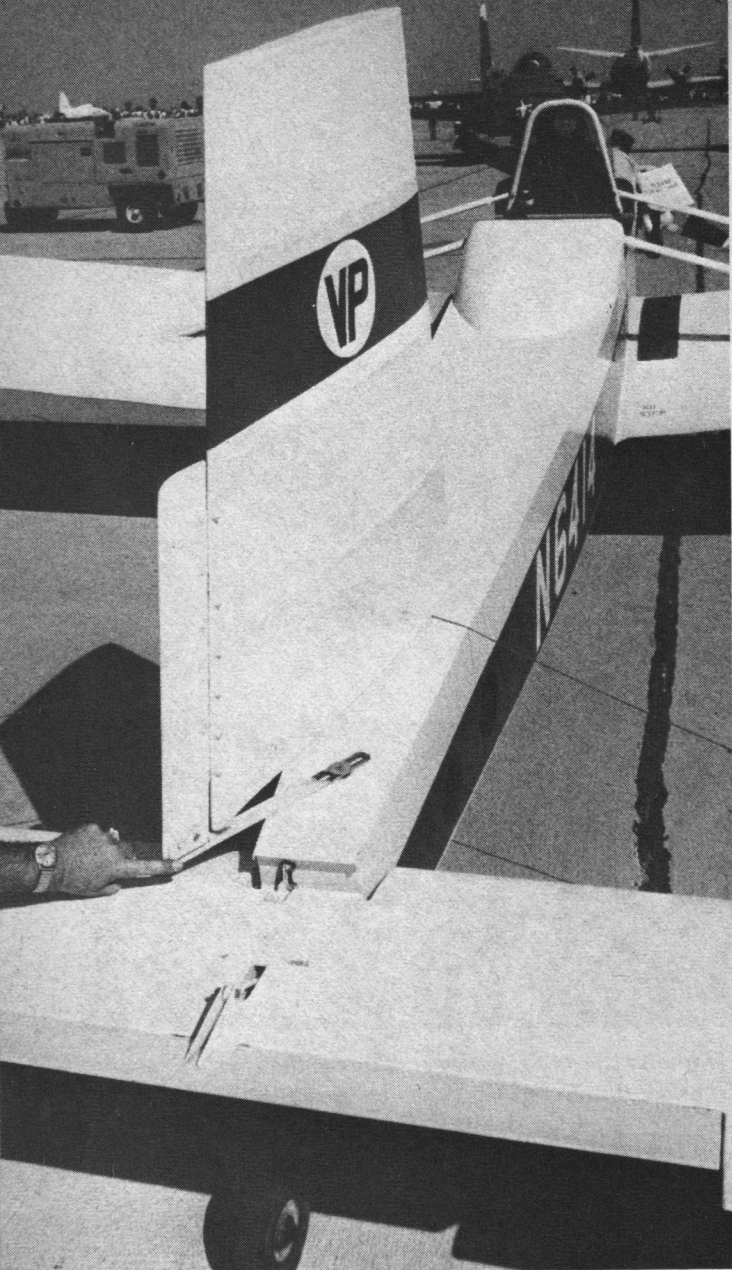
With the bulkheads finished and the firewall sawed to shape, he built the two fuselage sides. Two panels of 1/8th inch mahogany plywood form each side skin, which is clamped and glued to the longerons. Vertical braces are cut to fit and glued in after assembly, which Emmertson performed with the fuselage upside-down rather than rightside-up as called for in the plans. He felt that it would be easier to jig everything level and true using the top of the fuselage as the base, because the upper longerons are absolutely flat from firewall to sternpost and the whole assembly can be blocked up far enough to clear the two cockpit bulkheads and still be kept level.

After that, it was simply a matter of glueing on the 1/16th inch top skin, adding vertical braces and gusseting. "This is an enormously strong fuselage, because it is gusseted every which way with plywood, and some of the critical right-

How else can you simplify an airplane than the way Bud Evans has designed the VP-1?



You can feel super-safe with roll bar arching over your instrument panel.



All-flying stabilator eye-bolts to stern post; whole vertical tail pivots on tube.



Only cowling and fiberglass turtleback have compound curves — all else is straight-line.

angle joints are reinforced with ordinary pine quarter-round bought at any lumber yard and glued inside the joint," Emmerton notes.

As leisure between business trips permits, he plans to build the rudder next, but won't install it until he's completed the wings. Spar and rib material are already sitting in the garage waiting to be used.

"So far the fuselage has cost me between \$105 and \$110," Emmerton says. "And that includes a lot of mistakes I've thrown away."

He is sticking strictly to plans, and aiming for absolute economy, to the point of installing a curved wire "brush" type of tail skid in lieu of a steerable wheel, and planning to omit wheel brakes. "I expect to save a good deal on the 1200 cc Volkswagen engine, too," he notes. Since he travels regularly in Europe, he'll pick up an engine case at trade rates in Germany. This should enable him to mount a VW engine ready to fly for about \$250, in addition to adding still further to the international flavor of his project.

"I'm building this aircraft just simply so I can go aloft and waft about," he says candidly. "I wanted the smallest, cheapest-to-run airplane I could find, and here it is. The ease of building is an added bonus. It isn't a cross-country airplane, and will probably never go far from the Capistrano airport a few miles from my home. But when the weather is good and I feel the need to relax, I can jump in and spend a while cruising around, looking down at the unfortunates on the freeway."

With not too many hours in his log, Emmerton is preparing for the day when he'll fly the VP-1 by taking instruction and logging time in an Aeronca Champion. Anna Emmerton also is learning to fly, has already soloed, and makes no secret of her intent to make hubby share flight time in the VP-1. "We learned to fly here because it is too expensive in England," Emmerton said.

The VP-1 project has been a big morale-booster for Emmerton as far as confidence in himself as a builder goes. "If I can finish this one and fly it," he says, "then I'll feel I can tackle any other wooden airplane, because once the basic skills are mastered it is just a matter of time and devotion."

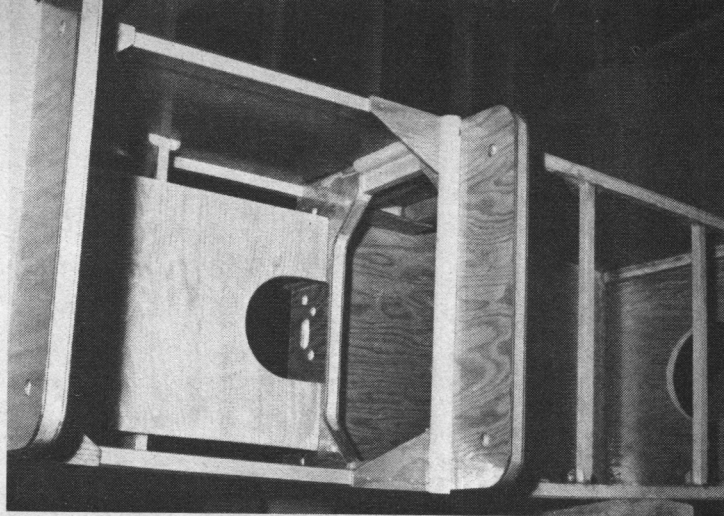
He believes that Evans really achieved the construction ease he sought to design into the VP-1, and that it is an ideal project for the beginner.

Evans says prospective builders seem to agree, though he refuses to divulge how many sets of plans have been sold. He does say that sales have been brisk outside the U.S., particularly in South Africa and Australia, as well as throughout this country. And he reports that the VP-1 Squadron, a mutual-aid group of VP-1 builders and fans, numbers almost 250 members. The squadron publishes a regular newsletter of construction tips, materials sources and other useful data for builders. It also offers a spruce kit which passes along to members the savings resulting from a volume purchase. Annual dues are \$5, and the address is VP-1 Squadron Headquarters, Box 1711, Austin, Tex. 78767.

Evans says that apart from a high sink rate common to short-span airplanes, the VP-1 flies very much like the Piper Cub. Full bore it indicates 85 mph. The rate of climb is 400 fpm, and landings normally are made with power and a touchdown at about 45 mph. The prototype, which started with a tail skid, has been fitted with wheel brakes and a steerable tail wheel and now takes off in 450 feet and lands in about 200, Evans reports. The stall is described as a gentle break straight ahead. Design empty weight is just 440 pounds, thanks partly to the light engine, and the gross weight is 650 pounds. Since the fuel tank holds eight gallons, pilots should lay off the eclairs for a month before climbing aboard.

Because Evans is a professional aircraft design engineer, he went about the VP-1 project in a professional way: a stress analysis on the entire structure and a flutter analysis on the horizontal tail have been performed. In addition, the stabilator and the rear wing spar were subjected to static tests. The airplane is stressed to 6.6 Gs ultimate load. It is not an aerobatic airplane, but it is a rugged little bug for sane fun flying.

Evans offers an information packet and sample construction drawings of the VP-1 for \$2.50, and a complete set of plans on 61 11-by-17 inch sheets for \$35. His address is P.O. Box 744. La Jolla, Calif. 92037.



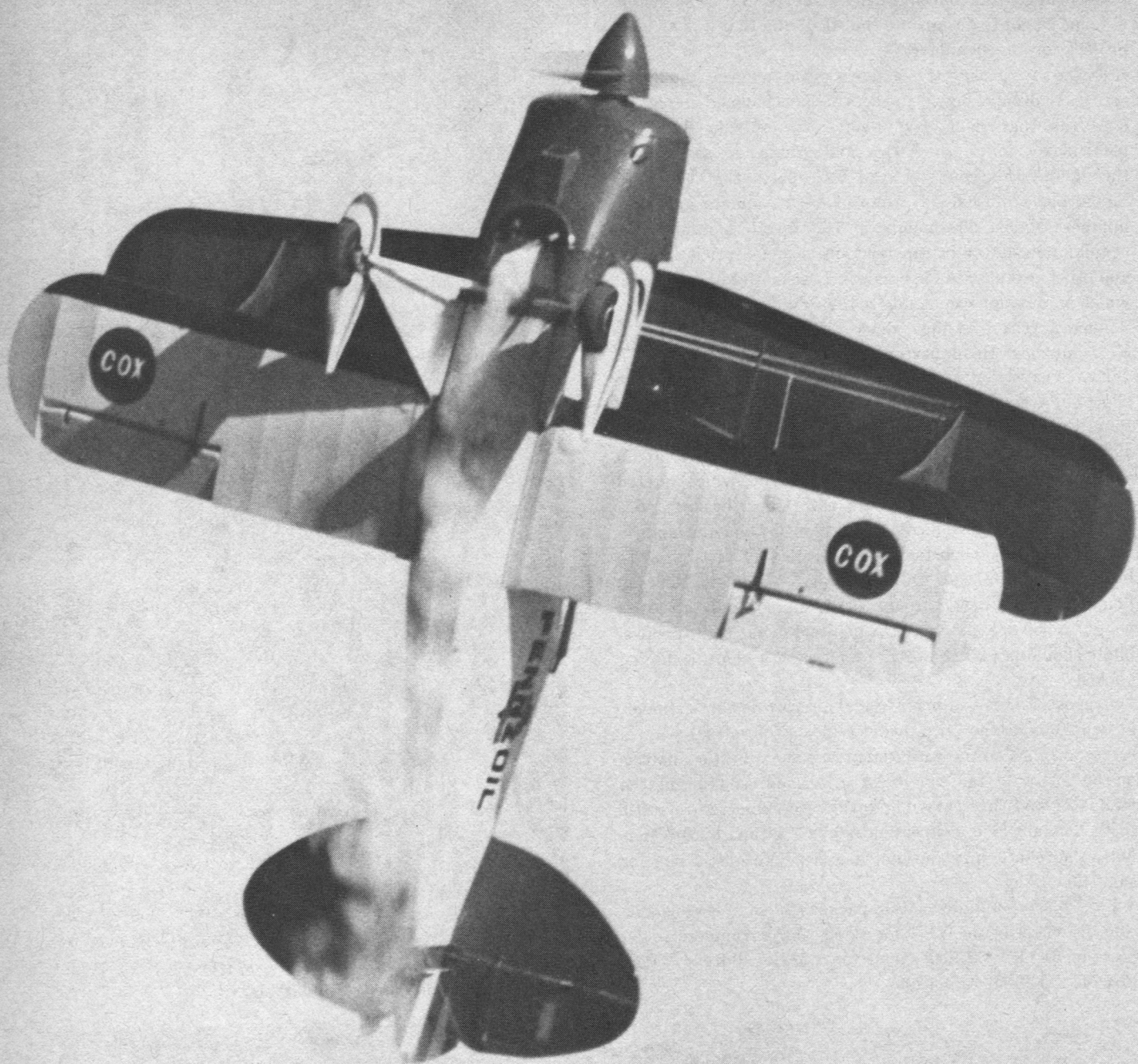
Anton Emmerton's VP-1 fuselage is utter simplicity, all amateur-built style.



Rushing home from office, Emmerton tries rudder ribbing on rear fin just for size.



A snakey paint scheme adds color to the VP-1, the world's simplest homebuilt.



The Pitts Special

ONE TEST OF a great airplane is whether its appeal spreads all the way across the spectrum of pilot interest from the complete beginner to the skilled and experienced veteran. By this test, as by most others, the Pitts Special is a great airplane.

To prove it, we went to one airman on each end of the scale: a relatively low-time pilot whose partially-completed Pitts Special is the only thing bigger than a model he has ever built, and one of the world's most expert and experienced competitive aerobatic pilots. One of the few things Brad McBee and Bob Herendeen have in common is a very high regard for the rugged little biplane Curtis Pitts developed years ago for the sport flying market.

McBee is a veteran aircraft assemblyman who now works as leadman for a firm which manufactures galleys for commercial jetliners. Herendeen is an airline pilot, and probably chauffeurs McBee's galleys around the sky. McBee has flown relatively little in recent years, because building an airplane takes most of anyone's spare time. Herendeen flies for a living, and on his days off he takes every opportunity to practice the aerobatic routines he uses in national and world competition. Both of them, however, are Pitts fans tried and true.

"As a matter of fact, it was Bob Herendeen who really got me sold on the Pitts," McBee says. A man who likes to be busy at something all the time, he had been casting around for an aircraft to build, and had looked at a number of possible projects. "Then one day I saw Herendeen perform at an airshow in his Pitts, and that settled it for me," he recalls. "I went home and wrote for the plans." In June, 1968, he began work in the garage of his home in Reseda, Calif.

Because he works at two jobs during the summer months McBee's airplane-building time is limited, and he decided to have the basic fuselage skeleton and main gear legs welded up in Pitts' Florida shops and shipped to California. He fitted wheels and the tail wheel assembly, then started work on the wings.

"I thought he'd be building the ribs forever," Mrs. McBee says.

McBee calls construction of the top wing the most difficult part of the project so far. "Getting that 12 inch sweep from center section to tips, and keeping everything exactly true, took some doing, but all that's really necessary is to keep at

it and don't let your impatience rush you," he cautions. He bought all the wood and fittings for the wings from Aircraft Spruce and Specialty Company in Fullerton, Calif. "I guess I was on those wings for a year or a year and a half, counting some time waiting for material and some periods when I couldn't work much on them," he says.

He is now working on the master cylinders and control systems, with fuselage forming stringers next on the list. After that, it's the engine. "I'm going to mount a 125-hp Lycoming with full inverted fuel systems, and she'll get night-flying lights and a radio. The covering will be Ceconite.

Like many builders who tackle aircraft with welded steel tube components, McBee has his welding done commercially after he fits and tacks the pieces. The balance of the metalwork, however, he is doing himself. Bob Herendeen went him one better in this respect: he bought the whole airplane ready-made.

Herendeen is no stranger to national aerobatic championships, and he came as close as any American has ever come to bringing home all the marbles at the worldwide competition in East Germany. He has flown all of the U.S. aircraft regularly used for competitive aerobatics, and most of the European types as well, including the fabled Jungmeister and the Zlin. His verdict on the Pitts, therefore, comes from a very solid background of experience with competitive types, and it is this:

"I think the Pitts Special handles better than any airplane I have ever flown."

Such a statement, coming from a pilot with Herendeen's qualifications, has to be considered quite an endorsement, but he's prepared to go even farther. "The Pitts has a more responsive rudder than anything I've ever flown," he says. "You NEVER run out of rudder in a Pitts, and the ailerons also are unusually effective."

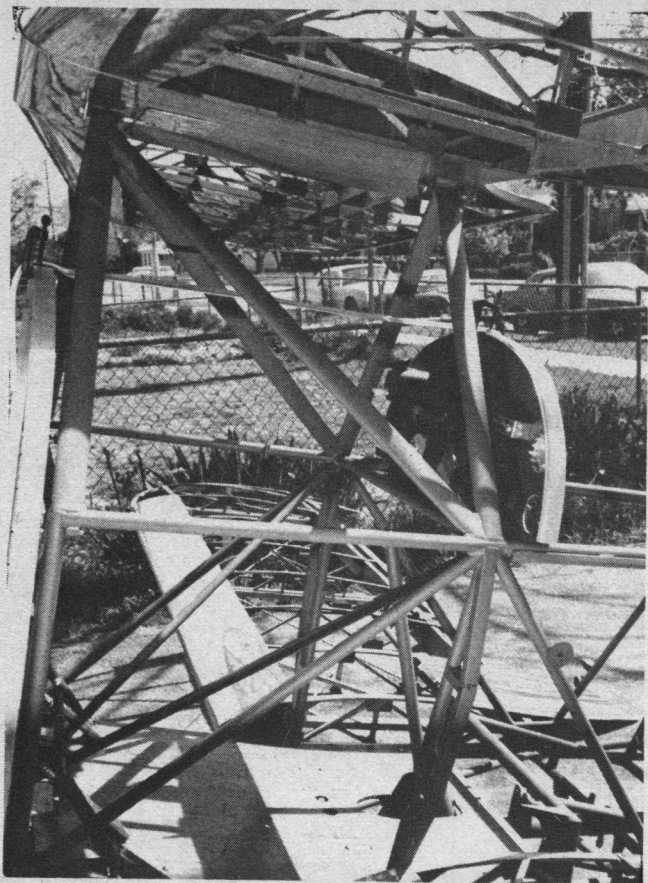
Herendeen's competition Pitts has the new symmetrical airfoil wings, with ailerons on all four panels, the top pair operated by push-rods from the lower pair. Ailerons and elevators are torque-tube operated for positive response, and only the rudder is controlled by cables. "The airplane is a joy to handle in flight, with no adverse yaw and plenty of crisp control response around any axis," he says. "In fact, the surfaces are so effective that they positively invite over-control, and a Pitts takes some getting used to when you fly one for the first time."



This closeup photo shows Bud Hines' Pitts Special in an unusual attitude — flying straight and level!



This two-placer is the Pitts S-2A another Curtis Pitts design in which you can scare your best girl breathless.



Robust cabane struts support a two-spar top wing. Ribs are built up small spruce pieces heavily gusseted.

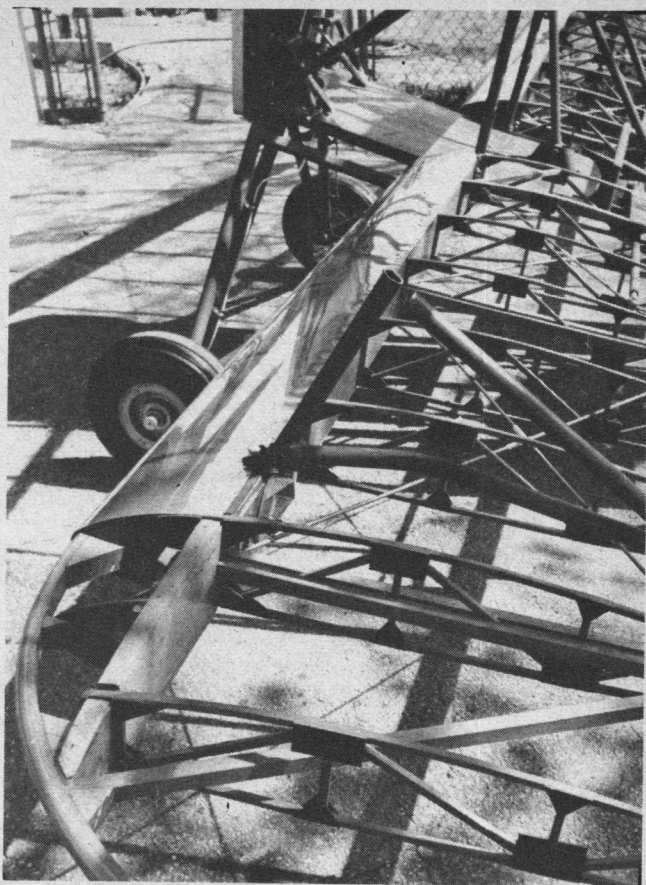
He strongly urges first-time Pitts pilots to get plenty of checkout time in taildraggers. "Log plenty of landings in a Luscombe or something like that," he warns. "In fact, if you can get checked out in the back seat of a Stearman you're all set for the Pitts, because when you round out to land you're completely blind from the cockpit forward."

The airplane is short-coupled, and needs alert handling on the ground. "I always advise new Pitts pilots to fly it first from a turf or dirt field rather than a hard-surfaced runway, because on a hard surface the tendency to groundloop is aggravated. When it starts to go off one way, it wants to go further in a hurry. The center of gravity is well aft of the wheels, and I find it almost impossible to make a decent wheel landing," he says.

A Herendeen approach amounts to 90 knots down final, slowing close in. "The Pitts has quite a high sink rate power-off, and you need the speed," he notes. "When you round out into the flare the airplane gets good ground effect, but tends to lose speed rapidly. I usually touch down three-points ahead of the stall, at about 70 mph."

He says that a big factor in ground handling is the setup of springs on the steerable tail wheel. Like most small biplanes the Pitts is a trifle squirrely, but if the tail wheel is properly rigged Herendeen says it is no more tricky on landing than any other short-coupled taildragger.

The Pitts is a small airplane, measuring 17 feet 8 inches across the top wing and 15 feet 5 inches on the lower. The wing area is 94½ square feet. Gross weight is 1,050 pounds,



Except for sheet metal leading edge and cowling, Pitts is fabric covered. Note steel tubing for interplane strut.

and various engines from 125 hp on up may be fitted. With a 180-hp Lycoming empty weight is given by Curtis Pitts as 717 pounds. This low figure is achieved with a structure which is unusually light. The upper and lower wings minus covering weigh only 110 pounds. Each aileron weighs 2½ pounds, and the basic fuselage structure of welded steel is only 35 pounds. Nevertheless, the Pitts is rated for 9 Gs positive and negative.

The Pitts is a far cry from the sedate, stable airplanes of the General Aviation fleet. It is, in fact, basically unstable, and that is one of the factors which cause it to be such a good aerobatic plane. "Mine will fly straight-and-level hands off until it hits the first air bump," Herendeen says. "Then it is on its way, and it won't recover by itself." He notes that the loading has a lot to do with stability. "I've flown 15 or 20 Pitts Specials, and they don't all handle the same way. If the CG is aft, they tend to be light on the elevator. If it is forward they're heavy. If you add an inch and a half to the motor mounts the airplane is very steady in cruise, but then it doesn't snap like a Pitts."

He has found that the symmetrical airfoil doesn't make any dramatic difference in handling, though it did achieve the desired effect of improving inverted performance. "Everything goes a little easier with the new wing," Herendeen reports. "It's a bit more solid upside-down, and will go around the loop, for example, at lower speeds than the original wing."

With the old wing or the new, the Pitts has always

excelled in roll maneuvers. "It will snap while you're thinking about it," Herendeen says. His air show routine includes a knife-edge pass which proves conclusively that a Pitts Special has three wings: the fuselage seems able to hold the airplane up all day with the wings vertical. "That is the rudder, again," Herendeen notes. "It doesn't look very big, but it never lets you down."

It does kick you over the top into a spin rather effectively, however. "The Pitts spins normally to the left, but it wraps up pretty tight in a right spin," Herendeen says. He never practices more than a two-turn spin, and advises against it in any airplane. "Guys call me up to ask about spin characteristics, and recovery techniques," he relates. "They complain that after about five turns this or that model of airplane flattens out or tightens up or what have you. What the blazes does anybody need to do five turns for? What are they trying to prove?"

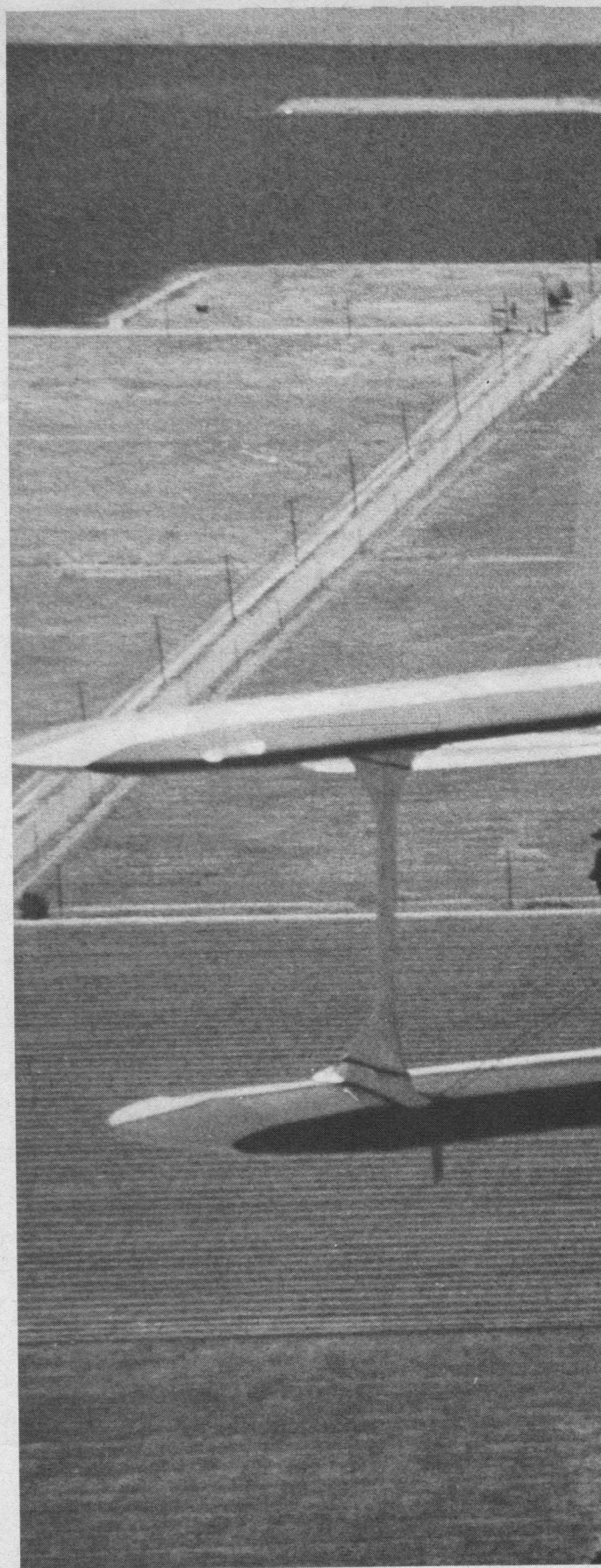
One thing the Pitts won't do, at least well enough to satisfy Herendeen, is a tailslide or whipstall. "It is just too stubby and short-coupled," he says. "Bigger airplanes like the Chipmunk will hang up there at the top of a vertical climb and slide straight on back, but the Pitts tends to twist off to one side." On the other hand, it snaps beautifully in any direction, and tumbles impressively in the Lomcevak.

Herendeen calls the Pitts an easy airplane to fly aerobatically, in terms of physical exertion. "It takes far less muscle to perform the maneuvers than it does in a plane like the Citabria, for example. If it didn't, I'd never be able to stand it myself," he says. And despite the first-glance impression of small size, he reports no problems at all with interior spaciousness. the opening of the cockpit is its smallest dimension, and the fuselage widens out below the opening to provide ample shoulder and elbow room. On the ground, of course, there is no forward visibility at all.

With his own Pitts still in the shop for new fuselage fabric and some minor modifications, he borrowed another plane to begin serious practice sessions for future competition.

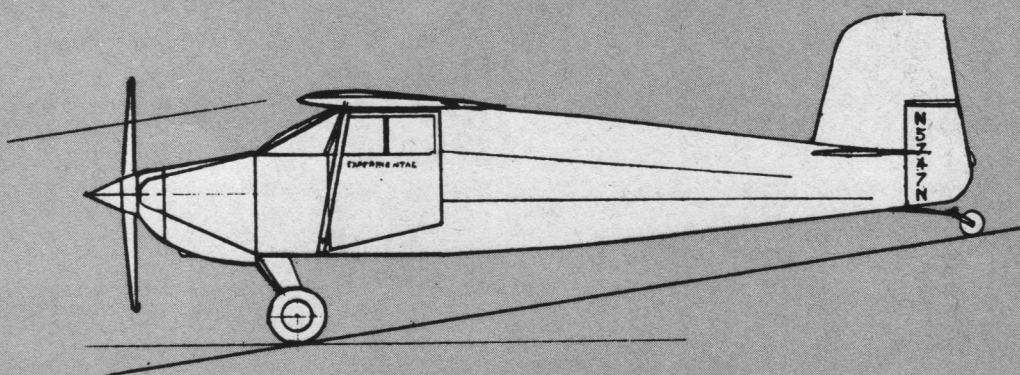
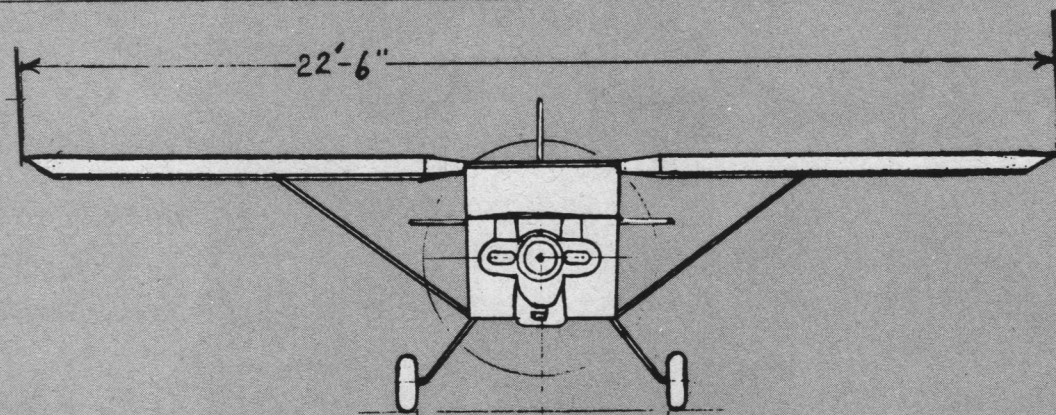
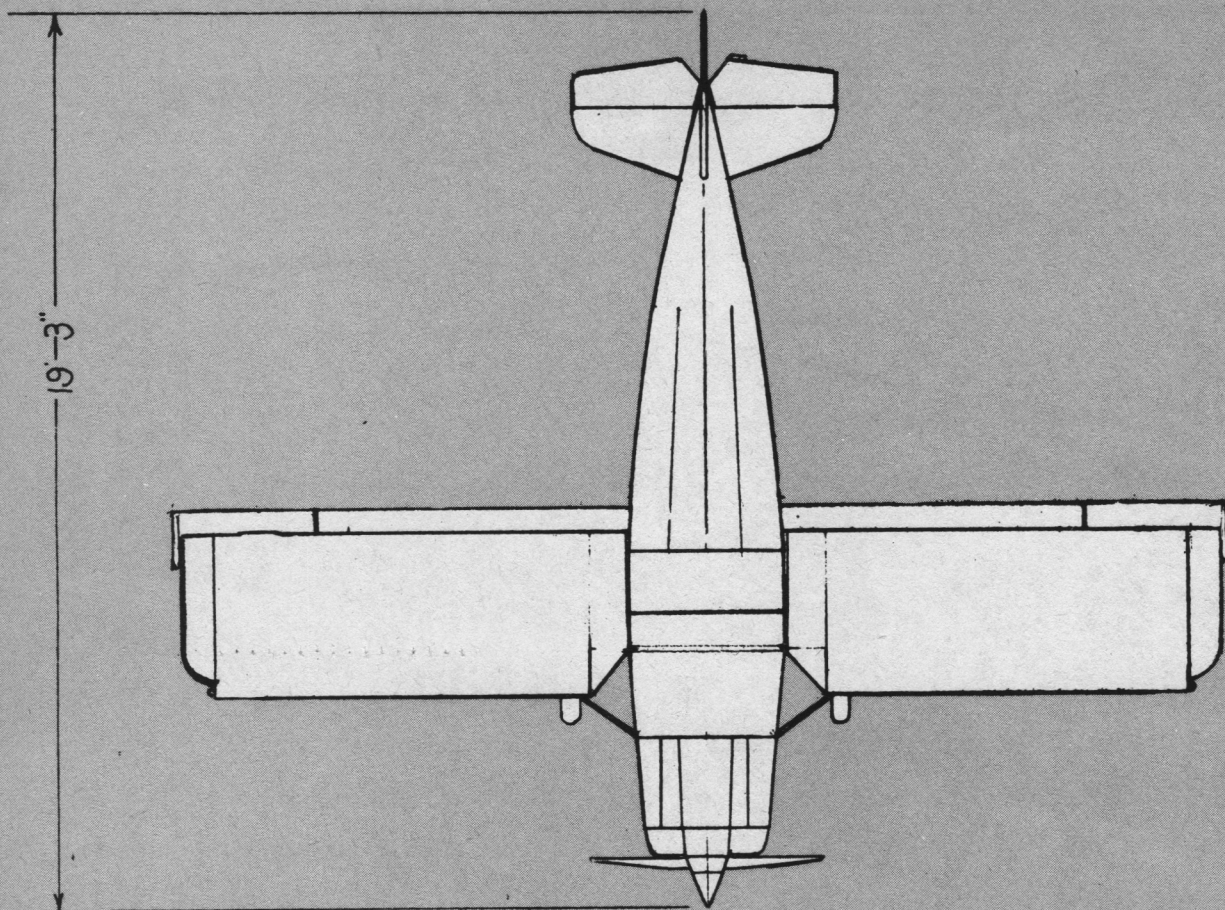
"Some people get the idea that competition pilots go up and fly aerobatics non-stop for hours," he notes. "The fact is, it is tiring to perform a competition routine, and I usually run through it about twice, then land for fuel and a rest before going up for another session. The number of days available for practice is limited by the job, of course, and there are always the problems of weather and other complications. That doesn't leave a great many practice days available between now and the world contest, and nobody can practice all day."

Perhaps not, but at some out-of-the-way practice areas in southern California when the weather is good between now and mid-July, a little red airplane will be kept busy for long hours doing vertical rolls, square loops, inverted 360 degree turns, hammerheads and all the other intricate maneuvers that must be woven smoothly together into an aerobatic routine. And in a garage not too many miles away another just like it will be going together. Brad McBee doesn't plan on entering any world aerobatic championships for a while yet, but he's itching to get up there in the same sky with Herendeen's Pitts and "roll his own."



Bud Hines and Larry Lilley fly in formation in their respective Pitts Specials across the Mojave Desert.





The Wittman Tailwind



THE SALARIES PAID to teachers in the public school system are notoriously low. In major metropolitan areas it is not uncommon to find that plumbers earn half again as much as teachers during the nine-month school year. So a teacher who wants to fly has his work cut out for him.

Bob Benefiel is a science teacher in the Los Angeles school system, and he likes to fly. An aviation fan and model builder since boyhood, he felt that he couldn't afford flying on a teacher's pay. But the die was cast when a school administrator offered to hire him to teach science if he'd learn to fly so he could also teach aeronautics. So in 1954 Benefiel took lessons in an Aeronca 7AC and got his license.

Then he started considering the matter of an airplane. He and his wife had a pact that if one learned to fly the other would, so they bought a Cessna 140, leased it to a flight school, and Mrs. Benefiel learned. Later they traded it on a 170. Benefiel then met Volmer Jensen, who was about to start work on his Sportsman amphibian, and Benefiel put in a great many hours helping Jensen on the project. "That's where I learned all I know about aircraft woodwork and glueing," he says.

He considered several homebuilt designs, but decided

they didn't fill the bill. "We want a plane with good cross-country capability," he explains. "My wife and I both love travel, and cross-country trips are our biggest thrill." His life for the next decade was powerfully influenced by a ride in a Wittman Tailwind, which he felt would neatly solve the combined travel and economic requirements of the Benefiel family.

Jensen told him of a partially completed Tailwind project begun by a builder who had to abandon it due to a heart ailment. Benefiel bought it and set to work in February, 1961.

"The builder had gotten no further than welding up the basic fuselage tube structure," he recalls. "I took it home and put it in a 15 by 32 foot workshop that I'd built behind my garage. It was that shape because I had originally thought of building a boat, but a weekend trip to Catalina convinced me that boats were too slow for a teacher with only limited weekend time.

"For the next 5½ years, my wife always knew where to find me," he grins. Except for a 10-week layoff due to illness, he worked regularly on the project during his spare time and on vacations. "I didn't know how to weld," he notes, but he



Squarish fuselage of Wittman Tailwind makes for simplified construction, and corner drag is reported minimal.

got instruction from a friend named Tex Hilley, now an instructor at Northrop Institute of Technology in Los Angeles.

Benefiel stuck strictly to the dimensions in the Wittman plans, and did relatively little improvising. "There are a few small changes," he admits. "Plans call for wood fairing stringers on the fuselage, but I substituted aluminum channels. I used a modified Maule tail wheel, altered the fuel system and installed a different pitch trim mechanism, but basically it is a pretty stock airplane structurally."

The Tailwind design is a pretty good one, as evidenced by

the fact that more than 150 Tailwinds have been completed, and at least another 100 are under construction. The reason for this is efficiency, a word which has been synonymous with Steve Wittman's designs for years. The Oshkosh, Wis., designer has all but dominated the Formula One racing world with his midget racers, and the Tailwind has been one of the most popular homebuilt aircraft ever developed. Plans sell for \$125, complete construction cost is usually about \$3,000 and the airplane is good for speeds to 165 mph depending on power.

The steel tube fuselage is perched on main gear legs of

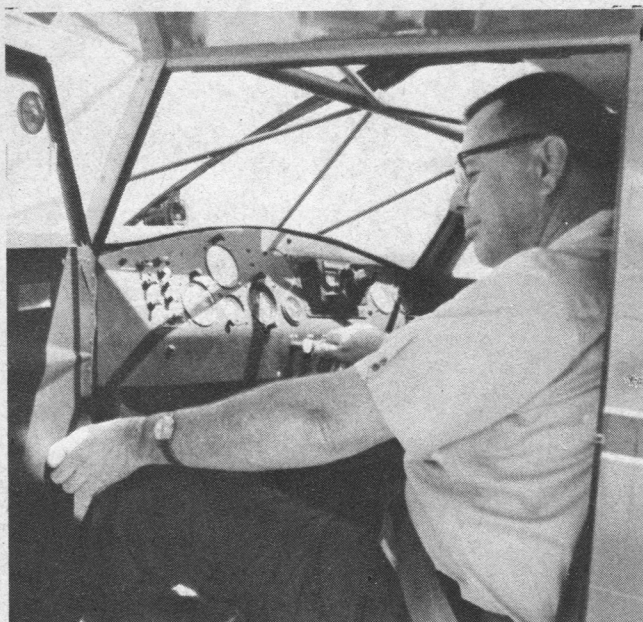
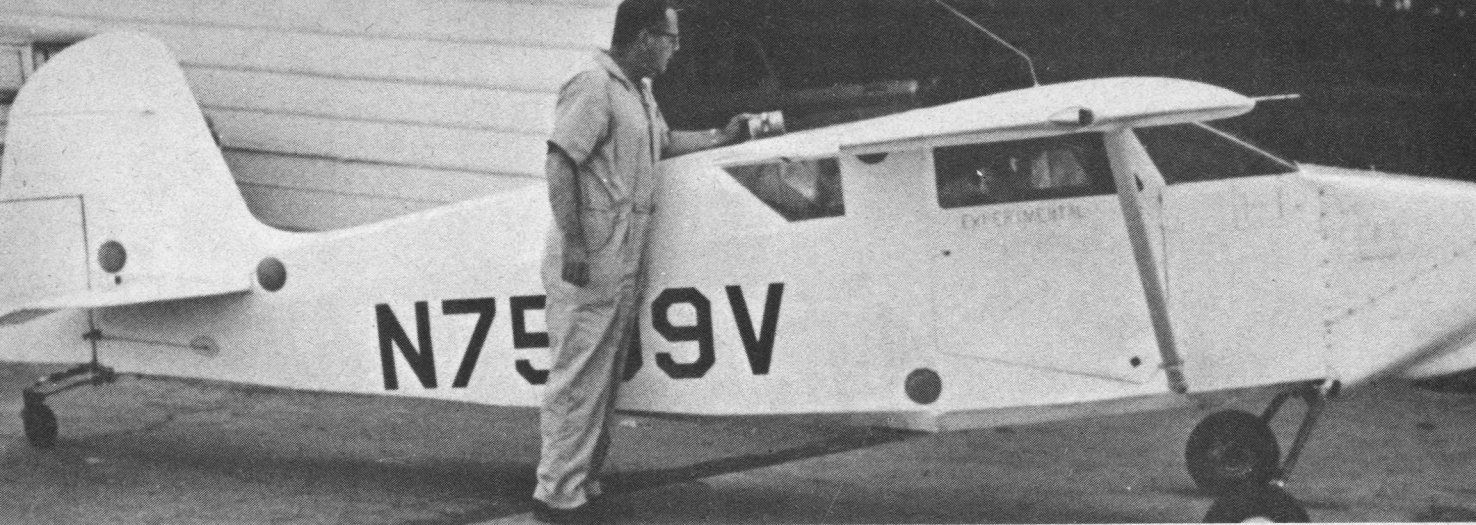


solid chrome vanadium steel bar stock, turned on a lathe and heat-treated. The upper ends of each leg form part of the welded truss engine mount. The tail wheel unit in Benefiel's plane was modified according to a Tex Hilley suggestion, and includes a single bungee spring rather than a direct connection between rudder and tail wheel. It will steer if rudder pedals are pressed hard, but it offers a smoother transition from taxiing to flying. Cleveland wheels and brakes are fitted to the main gear.

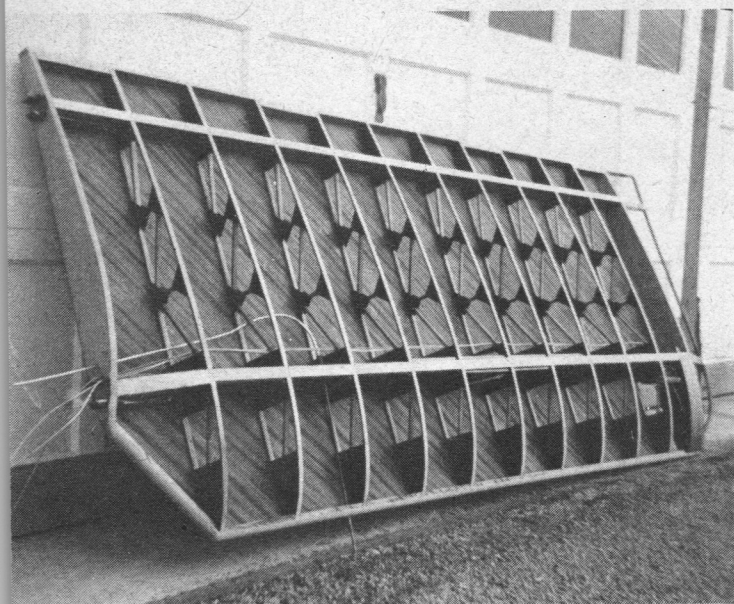
The Tailwind wing is built of solid spruce front and rear spars, with built-up struss ribs using spruce cap strips.

Internal drag bracing is avoided by skinning the wing with 3/32nds inch mahogany plywood. Each spar bolts to heavy tubular carry-through members in the cabin roof. A floor-mounted handle operates the two-position manual flaps, in which steel channel ribs are welded to the actuating torque tube. The mass-balanced ailerons are built in the same way and also are torque tube-operated.

"The two-position flaps are mostly drag at the 30 degree setting, but they do give me some lift on takeoff at the 15 degree position," Benefiel notes. "It took me about four years to discover that, but they do."



Steve Wittman suggested flattening side of exhausts and drilling holes in bottom to reduce the sound level.



Tailwind uses wings of conventional wood structure and ply skin, with a lift strut attached to main spar.

The entire wing structure is covered with fabric and doped. "Getting that fabric onto the wing skin with a squeegee without any air bubbles under it was a real chore," Benefiel recalls.

Since he had never covered an airplane, or anything else, with fabric before, the Tailwind represented a major challenge. "I learned how to do fabric work from Mrs. Betty Frohman, whose late husband used to have a Bellanca dealership at Torrance airport," Benefiel says. "She taught me a rib-stitch with a disappearing knot that took a while to learn."

The powerplant originally was intended to be a converted Lycoming ground power unit of 125-hp, and Benefiel had two of them. But Tex Hilley had a newly majored 90-hp Continental and he wanted a GPU, so a swap was effected and the Continental was installed in the Tailwind, driving an altered propeller from a Culver Cadet. The polished aluminum blade of 63-inch diameter originally had 63-inch pitch, but when Benefiel flew the airplane to Oshkosh to visit the designer, Wittman suggested changing the pitch to 61 inches to allow the engine to turn up to higher rpm. The change was made and proved successful.

Original plans call for a 25-gallon fuel tank between the instrument panel and the firewall, but Benefiel decided to mount a shallower 15-gallon tank there and put another of the same size behind the right seat. He uses the latter only for cross-country flying. By using the smaller tank in front, the filler neck can be recessed into the cowlings instead of piercing the windshield as on the original plans. Also it enabled Benefiel to install an air-tight box over the tank and vent fumes overboard. The same is true of the rear tank, which also improves trim at gross weight. A still further advantage of the smaller forward tank is an increase in radio room on the panel.

In August, 1966, the airplane was ready to fly, and was trucked from the Benefiel back yard to Chino airport in the eastern Los Angeles basin. About two weeks were required for assembly, checking everything "from three to six times" and conducting slow and high-speed taxi trials. "Finally, on our wedding anniversary, there was nothing left to do but fly it," he says. So, with Mrs. Benefiel grinding away with a movie camera, the proud builder lined up and took off.

"It took between 800 and 900 feet to lift off, and everything went just fine until speed began to build up, at



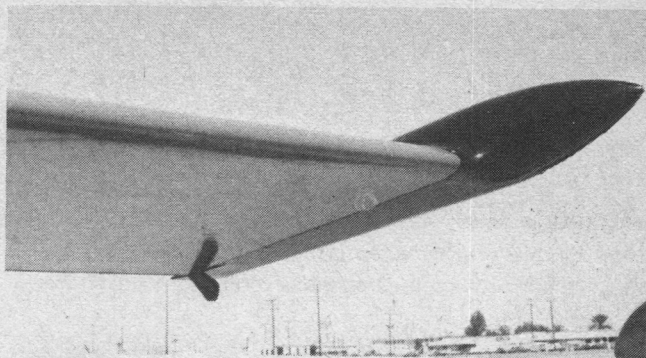
which point things got interesting. The original friction-type pitch trim proved inadequate, and the faster we went the lower the nose went. At the same time the left wing wanted to go down. It was a two-handed job to hold the nose up, and the throttle was too far away to retard with my teeth. Both hands were busy, both knees were shaking and all that sweat wasn't due to the high August temperature. I about decided that test piloting was not my line of work," Benefiel recalls.

He finally got things tamed down and decided to go upstairs for a little careful exploration before trying to land a nose-heavy airplane for the first time. At altitude he quickly discovered that with power retarded there was no pitch problem, and a slight shudder preceded the stall at about 70 mph. "I decided to come in about 85, and the landing was uneventful," he says. "But the first thing I did was change the angle of incidence on the tail." The plans provide three holes in a welded steel plate in the rear fuselage into which the fitting on the stabilizer leading edge can be bolted. "I guessed wrong and put it in the top hole," the builder explains. "The high-speed taxi tests worked fine, but flight loads told a different story. I moved it to the middle position and tried that, but it still left me nose-heavy at speed. I dropped it to the lowest notch, which worked excellently."

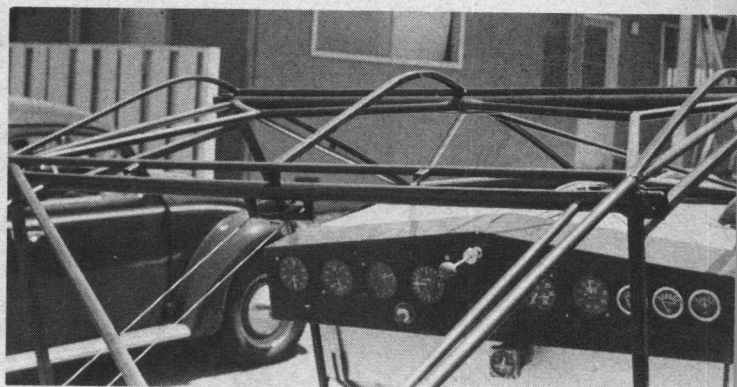
The pitch trim also came in for modification, and another Tex Hilley suggestion was adopted. This involves the use of a standard vernier prop pitch control to actuate a flat steel tab piano-hinged to the right elevator. This provides very positive and at the same time very delicate pitch control from the vernier handle which angles forward and up between the seats adjacent to the flap handle.

The left-wing-low problem was solved by raising the trailing edge of the flap slightly. The students of Benefiel's Washington High School class contributed another idea: a handy aileron trim system using a spring attached close to the bottom of each control stick. By adjusting spring tension with a simple worm screw the horizon can be brought nicely level across the windshield. This is quite handy in the Tailwind, which is relatively sensitive to unbalanced lateral loads.

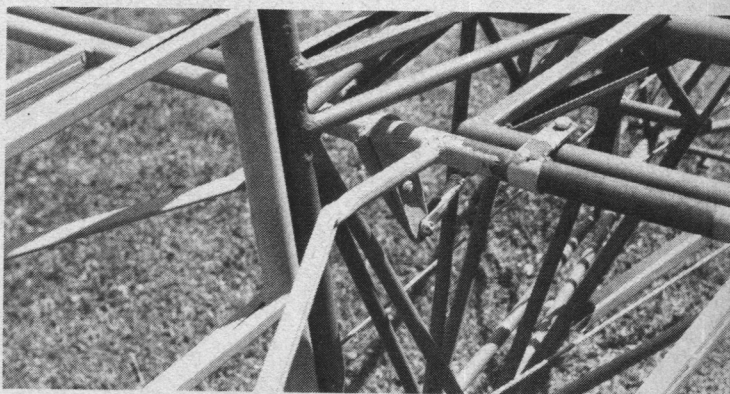
When adjustments were completed Benefiel set about to measure the Tailwind's performance, and the figures are impressive. Speeds were tested by flying beside an airplane



Various Tailwind modifications are possible: this bird has wingtip plates that resemble tanks but they aren't.



Curved fuselage top between and above wing spar carry-throughs adds a lot of lift to boost Tailwind's performance.



Detail of rugged all-metal tail group shows vertical tail built as part of fuselage, method of hinging rudder.



John Beyreis' Tailwind, built in '56, draws admirers at fly-ins where homebuilders trade secrets with each other.



Completed fuselage structure of Bob Benefiel's Tailwind is almost ready for the engine and fabric covering.



Tailwind's spindly gear legs are a hallmark of its simple design.

with a carefully calibrated airspeed system, and they show that the Tailwind cruises at 150 mph TAS on 2,500 rpm. With full power, 2,750 rpm gives a top speed of 158 mph, which is moving right along on 90 hp. On one flight the airplane was still climbing at 13,500 feet, but Benefiel didn't want to go higher without oxygen. Numerous tests on cross-country trips have confirmed that at 150 mph the airplane burns six gallons of 80 octane fuel per hour, and runs six hours minimum between one-quart oil additions.

"In a level attitude there is not much ground clearance for the prop, so I don't raise the tail on takeoff," Benefiel says. "I just lift a little of the weight off it, and let the airplane fly itself off in a three-point attitude, which it does at about 80 mph with one notch of flap. I don't wheel-land it for the same reason. With an approach speed of 85 mph true, slowing in the round-out, she touches down three-point at about 80. It is not much more difficult to handle than the Cessna 140, though everything happens a bit more quickly."

The empty weight of Benefiel's airplane is just 808 pounds, and the gross is 1,366 for a useful load of 558 pounds. The battery is mounted beneath a 50-pound-capacity baggage well behind the pilot, and clothing and other light luggage can be carried on the shelf around the well and on top of the aft fuel tank.

During construction he installed navigation and landing lights, and fitted post-lighting on the instrument panel. The white tail light on the rudder was the gear-down light from a T-28, and the FAA refused to approve the airplane for night flight on grounds this light wasn't bright enough. So rather than tear up the beautiful covering job on the rudder, Benefiel has not flown at night. He suggests that builders who want night flying approval take care to use acceptable white tail lights.

A great many airplane owners add things as they go

along, and Benefiel is no exception. The Tailwind started life as a noisy airplane, and sheets of polyurethane plastic were glued to doors, walls, firewall and ceiling to help lower the cabin sound level. It was still noisy, but when the Benefiels visited Oshkosh, Steve Wittman suggested partially flattening the sides of each exhaust stack and drilling holes in the bottom. "This works very well, and cuts down the noise level noticeably," Benefiel says.

The Benefiels are off and traveling in the airplane as often as their busy schedules allow. In addition to school term teaching, Benefiel also conducts aviation ground school classes. "My wife also teaches ground school," he notes. "In fact, she has more ratings than I do." They own property in northern California, and make regular flights there on weekends when they aren't attending the many fly-in events scheduled in the southwest.

Plans for the airplane at \$125 per set are available from Steve Wittman at Box 276, Oshkosh, Wis. 54901. Wittman has recently developed a wing 19 inches longer than the original which offers better climb, higher cruise speed at altitude and lower takeoff and landing speeds than earlier Tailwinds.

The airplane can be (and has been) built with tricycle landing gear, using a free-swiveling non-steerable nose wheel which casters behind a spring steel gear leg. Some builders also have modified the wingtips and made other changes, but not all of them are beneficial to performance. Several years ago California owner George Gruenberger bought a Tailwind which had been built with the tri-gear. The fuselage was two inches wider and two inches deeper than standard, and the wingtips that look like small tip tanks but carry no fuel were installed. A 125-hp converted GPU powers the airplane. Gruenberger says it cruises "at about 150," and thinks it may be the slowest Tailwind.



Extra Care In Homebuilding

FEW HOMEBUILTS IN recent years have been more popular than John Thorp's T-18, for which 731 sets of plans have been sold to date. About 50 T-18s are flying, and a number of others are nearing completion. It looks like a real success story, but listen to the designer:

"I'm not ashamed of the T-18, but I wish I had never designed it. It seems to be touch and go whether the good the advanced design has done for the homebuilt movement outweighs the harm caused by four accidents."

John Thorp is a dedicated supporter of the homebuilt movement, and a professional airplane designer. He did a great deal of the basic design of the Piper Cherokee and the Wing Derringer, and all of it on the Thorp Sky Scooter. All three of these are type-certificated airplanes. He has also been involved in the design of the landing gear for the Pocono, Piper's fat little feeder liner. He is a trained and experienced aircraft design engineer, and relatively few people connected with the homebuilding field are technically qualified to disagree with him. What Thorp has to say about homebuilding, consequently, becomes a matter of some importance.

"Homebuilders are starting to run into the same sort of problems today that professional aircraft designers first encountered in the early 1930s," Thorp explains. "Speeds and loads have moved up to the point where some homebuilts are equalling the best planes of that period in performance, and problems of materials, stresses and advanced aerodynamic design may be getting out of hand."

The problem, as he sees it, is that not everybody who might wish to do so is competent to build a safe airplane. "No airplane can be taken lightly," he says. "It is not something that just anybody can do. A builder must have pride and satisfaction in doing a job right, but he must also have the manual dexterity and technical capability to do it that way. If a prospective builder tells me he has built a house, or a boat or hotrod or dunebuggy, then I figure he might have a 50-50 chance of finishing a good airplane."

He feels that economy is greatly over-emphasized in promoting the growth of homebuilding. "The idea that homebuilding is a cheap way to get an airplane is a fallacy," he warns. "It won't fool anybody except maybe your wife. To fly soon and cheap, go by a wrecked Cessna 150 from an insurance company and rebuild it. You'll achieve your flying objectives much quicker."

For a man who designed one of the easiest-to-build high performance two seaters on the market, these comments might sound like heresy, but that isn't Thorp's intention. He wants to put a damper on wild enthusiasm, and call attention to the fact that many modern homebuilts operate in stress regimes where there is no place at all for amateurism.

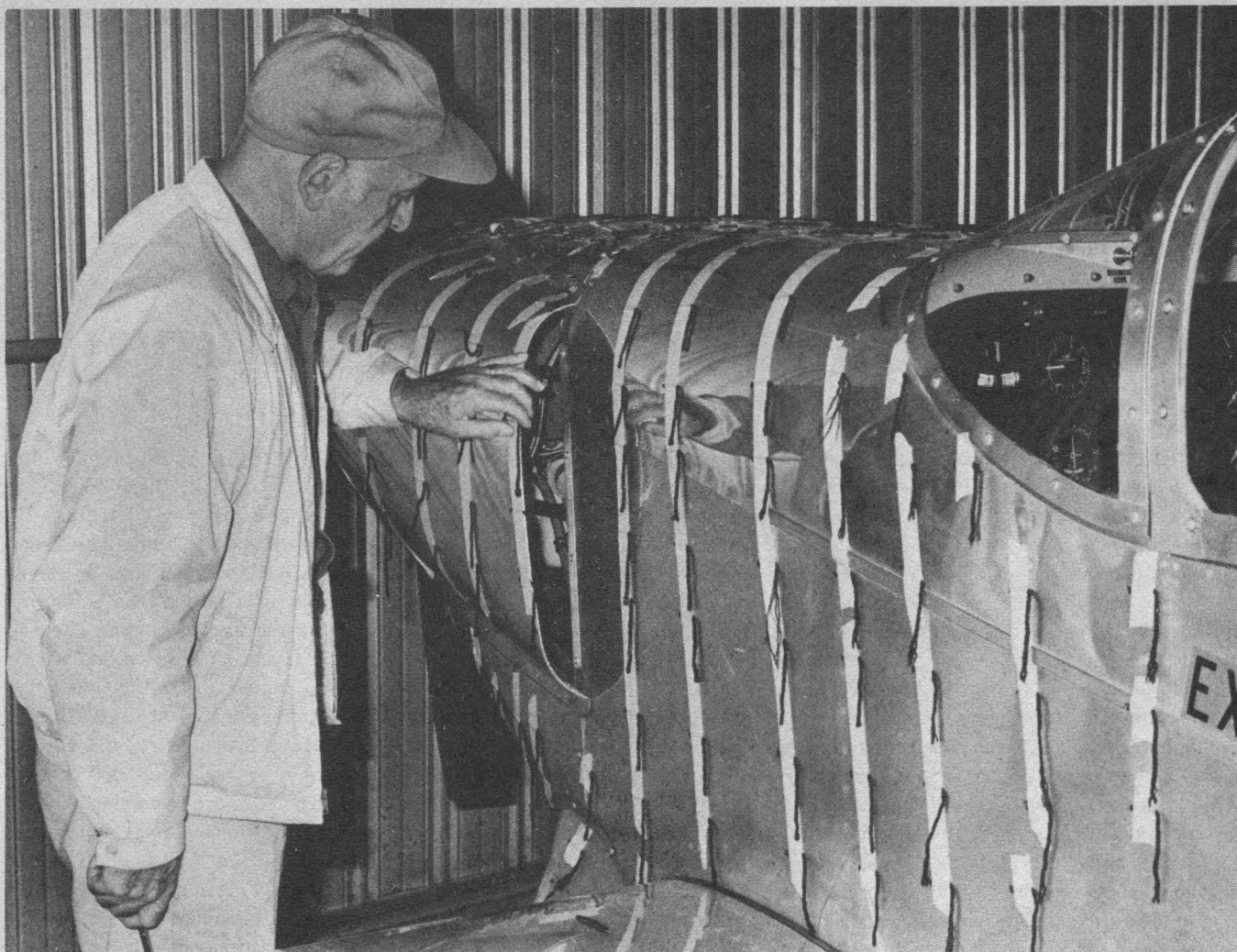
"Back in the 'Thirties," he recalls, "an engine like the Lambert turned at 2,350 rpm, and this was considered a high-rpm powerplant. Most engines were in the range between the Kinner, at 1,750, and the Menasco at 2,275. But today an rpm of 2,700 is common in flat fours, and a great many homebuilders wind them up closer to 3,000 rpm."

Stress levels in props, Thorp notes, are a function of angle and dynamic pressure. High performance homebuilts regularly encounter steep turns involving high blade angle of attack, and dynamic pressure itself is a function of speed, so stress levels become matters of genuine concern.

"The strain on props doesn't rise as the square of rpm, because prop diameter is generally smaller now than in the old days of slower turning engines," Thorp admits. "Nevertheless, the strain does go up faster than a function of the first power." To homebuilders, what this means is that something which worked well on a friend's plane at 125 mph may fly right off the front end of yours at 175 mph.

Even at speeds well below 100 mph, flutter of ailerons, tail surfaces and even whole wing panels, has been encountered in homebuilts. When you are building a plane which will cruise at 150 or above, and which may well pass 200 mph either accidentally or on purpose, aerodynamic flutter is instant death. Thorp is concerned that many homebuilders may have far too casual an attitude about the problem. "They'll say they never intend to exceed safe speeds," he points out. "But nobody ever intends to overstress his airplane — it happens when you get into turbulence, or lose orientation in clouds, or fall out of the bottom of an aerobatic maneuver. In a clean modern design, speed can pick up with frightening suddenness. Since we all know things like this can happen that even a well-intentioned pilot can't avoid, we know that the only way to defend against them is to make certain that the design and construction of the airframe itself are proof against any strain likely to be placed on it."

It is precisely here that Thorp feels a major danger lies for the homebuilder. He notes that there is no way to insure uniformity in construction, once the plans have left the



John Thorp glued wool tufts to his personal T-18 to discover a way to cut down drag of engine-cooling air.

designer. "The skill of different builders varies. They use different engines, different mounts. On all good plans the precise specifications of the material to be used are called out, but builders sometimes decide to use available material that would give the designer the screaming horrors if he know about it."

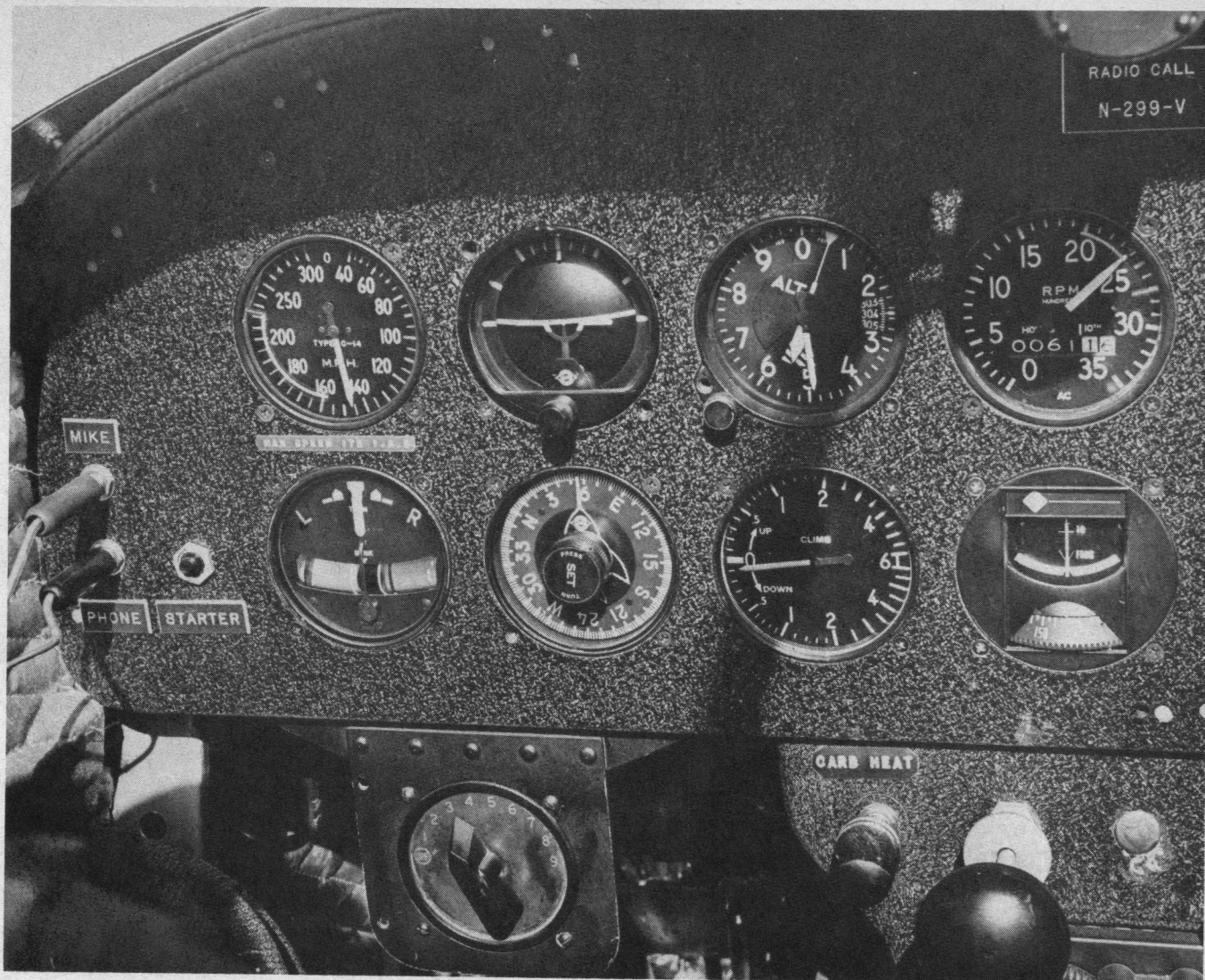
He knows whereof he speaks, because he has made himself familiar with the considerable number of the T-18s built so far, and virtually every one of them is a one-of-a-kind airplane in some respect. "There is one T-18 flying that I'm ashamed to be on the same airport with," Thorp says. "The builder wanted to fly in the worst way . . . and he is! I have no evidence that the airplane is unsafe, but it sure is raunchy-looking, and that makes me wonder about the rest of the workmanship."

The stock T-18 is such a good airplane — 170 mph on 125-hp — that anything less than correct construction can be a serious danger to structural integrity. In the first two accidents, tail flutter was suspected in one and actually witnessed in the other. John Thorp promptly invested \$12,000 of his own money in hiring a professional firm, Specialized Testing Service of North Hollywood, Calif. to perform a flutter analysis on a redesigned horizontal stabi-

lator he beefed up to cure the problem. The new tail was installed in a borrowed T-18 and subjected to ground shake tests to establish the natural vibrating frequencies of the structure.

The airplane was then heavily instrumented and flight tested, with the controls pulsed at various airspeeds while strain gauges coupled to a 14-channel oscillograph recorded the behavior of the stabilator under flight loads. The first test showed good vibration damping at 170 and 180 mph, but at 190 mph the instruments recorded an undamped oscillation which the pilot could not detect. It represented, nevertheless, an incipient flutter at a speed fully 10 mph below that at which the same aircraft had previously been flown to establish safe speed levels for the design.

Modifications were performed and additional testing resulted in a full-blown flutter which the pilot was able to stop by instantly chopping the throttle. This flutter was induced by control pulsing at 175 mph, but later on the same flight, during a let-down at only 165, flutter again occurred. Further modifications to the balancing weights and the trim tab control arm cured the problem, and instrumented flight tests showed good natural damping of induced vibrations at speeds from 150 to 233 mph calibrated indicated airspeed.



Professional instrument panel is a mark of the integrity of the T-18 design — simple and well laid out.



High school teacher Fred Ferdon chose a Thorp T-18 for his class to build, for ease of construction.

As a result, a red-line speed of 210 mph was established for all properly modified T-18 aircraft, and drawings of the new tail surface were supplied to all builders.

Problems of this sort also are potential hazards for other high-speed aircraft, and solutions — even expensive ones — are made difficult by the fact that individual aircraft built to the same set of plans can be so different, Thorp warns.

The machine he is most concerned with is an all-metal two-seater with a low wing and tailwheel landing gear, with chief design emphasis on ease of construction for home-builders. The T-18 uses the 125-hp Lycoming converted ground power unit, or certificated Lycoming aircraft engines of 125 to 180 hp. Thorp recommends a fixed pitch prop, because a constant-speed unit is 47 pounds heavier and requires 13 pounds of lead in the tail for proper balance, for a total weight penalty of 60 pounds.

Thorp pioneered the use of "matched hole" assembly techniques, in which templates are used to drill rivet holes in components prior to assembly, and assembly requires no jigs. Pop rivets may be used, and flush riveting is recommended to take full advantage of the extremely clean aerodynamic design.

The landing gear is an unusual A-frame assembly welded of thick-walled 4130 chromoly steel tubing, attached to the fuselage at three points. The engine hangs on the front side of the A-frame, and metal arms cradle the fuel tank on the opposite side so the fuselage structure itself bears none of these loads in landing.

Thorp designed the wing so that it can be lowered to the ground behind the gear by removing self-locking pins at the four wing attach points and at the forward end of the elevator push-pull tube. The wing, with control sticks attached and the aileron system intact and fully rigged, can then be mounted beside the fuselage on a suitably modified boat trailer and hangared at home.

The wing is built in three pieces, a straight center section and outer panels incorporating dihedral. The aircraft normally is built with flaps, but some are flying without them. It also is possible to build the T-18 as a tri-gear, but Thorp is absolutely opposed to this because the fuselage structure requires extensive beef-up to handle landing loads if the main gear legs are moved aft of the firewall.

The T-18 is a comfortable cross-country aircraft, with a side-by-side cockpit three feet two inches wide and visibility to spare out of a full bubble canopy. Performance and specifications differ with power, but the airplane spans 20' 10" and is 18' 11" long. In the taildragger version the main wheels are 5' 3" apart for a stable ground stance.

In the "Sport" version with canopy, flaps, wheel fairings, electrical system, etc., Thorp says a 140-hp engine will deliver 170 mph top, a rate of climb of 1,100 fpm at a gross weight of 1,413 pounds, and a cruise speed of 150 mph at 10,000 feet on a mere 65 percent power. At this power setting and altitude, range is 560 miles. Loaded to a gross weight of 1,250 pounds the T-18 meets requirements of the aerobatic category, with load factors of 6 positive and 3 negative Gs. The ultimate load factor is plus 9, which indicates a robust structure. ●



High performance of the Thorp T-18 comes from its splendid design by a professional, skilled engineer.





Building The BD-4

NO SPORTS PLANE design ever offered to the American homebuilder has attracted as much attention — both from builders themselves and from the aviation press — as Jim Bede's BD-4, until his BD-5 Micro came along.

When it burst upon the do-it-yourself airplane scene the BD-4 was hailed as the Great Breakthrough — the first high-performance homebuilt four-seater that was both low in cost and so easy to build that even a little old lady from Pasadena could hack it. The passage of several problem-filled years has done little to dim the interest of either builders or the press.

It is doubtful that any serious aviation fan in the country is unfamiliar with the general concept of the BD-4, which introduces a number of dramatic innovations to homebuilding. Chief among these are the basic fuselage structure of bolt-together aluminum angles, and the use of die-molded fiberglass nesting airfoil sections bonded to a tubular spar to form the wing. Suitably sealed, three or more of these "panel ribs" in the inboard section of each wing form the fuel tanks.

Bede also engineered a swing-out engine mount, which pivots on at the top and bottom attach points on the right side to permit easy access to the engine and accessories for simplified maintenance and repair. He cut cost and construction complexity by employing a non-steerable castoring nose gear, and made extensive use of pop-rivets and the metal-to-metal bonding approach he pioneered for light aircraft on the BD-1, which eventually became the American Aviation Yankee.

A great many enthusiastic things have been said about the BD-4, and nobody has said more of them than Bede himself. On the other side of the coin, the airplane (and the designer) have more than once been the target of less than complimentary remarks in the press. The editors decided to approach the subject of a BD-4 report by going directly to some of the people who are building it, and basing the article on their views and experiences rather than on the airplane itself or what Bede has to say about it. The result of this approach has been to confirm that much of what Bede has said is true, and so are many of the comments made by others that he doubtless wishes had never been published.

Bede sells the plans for the airplane for \$30 — a favorable comparison to the \$100 or more commonly charged for other popular homebuilts. In addition, he offers various parts and material kits, up to and including a total package which con-

tains an engine, all the sheet and tube metal, and every other piece of the airplane down to the last nut, bolt, rivet and washer.

Glen Bennett, a California Bede enthusiast, is ruefully aware that a lot of BD-4 builders who bought Bede's plans are not buying Bede's kits. They are going to local suppliers for some new material, and scrounging for odds and ends at bargain rates wherever they can find them. In the Los Angeles area many homebuilders are employed in the aerospace industry, and have no difficulty finding "contacts" who can provide sheet metal, bar stock, hardware and virtually anything else they need. On a nationwide basis, Bede has sold some 1,300 sets of plans. At press time he was listing just under 400 active builders to whom he has supplied some or all of the material.

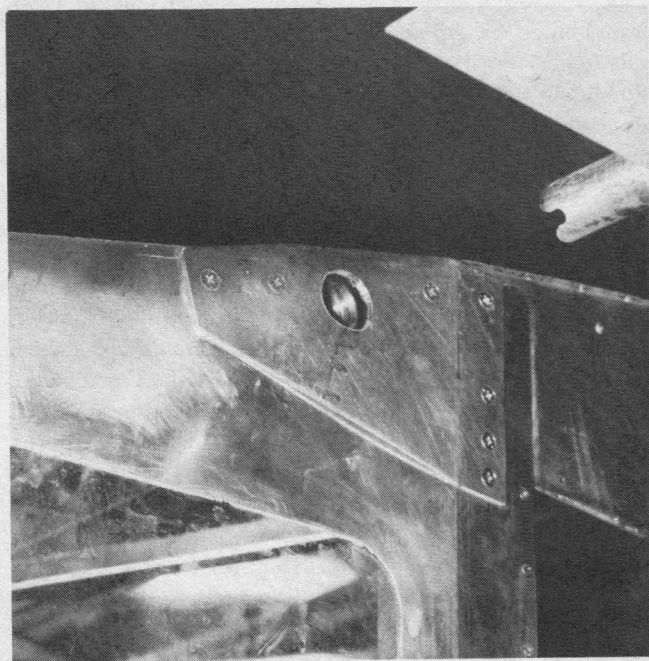
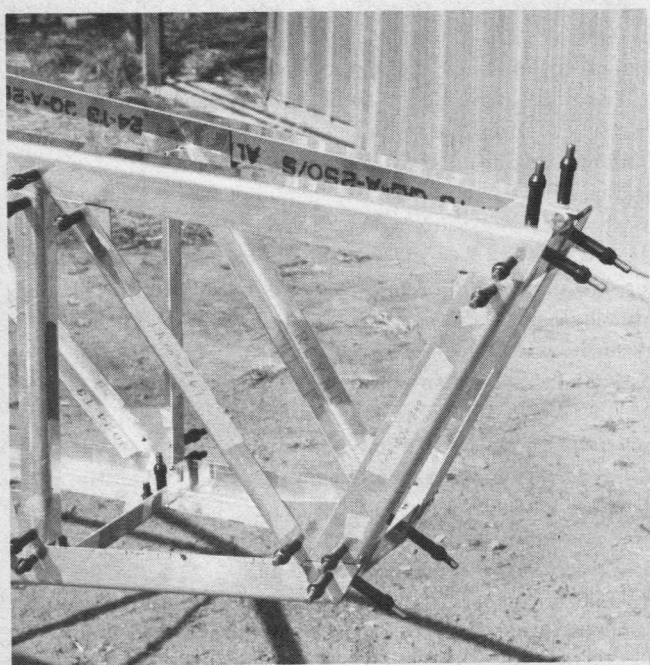
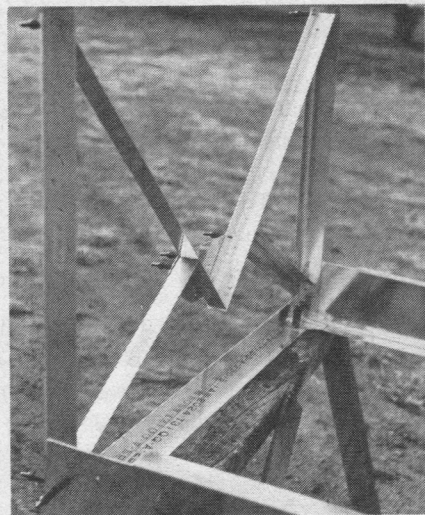
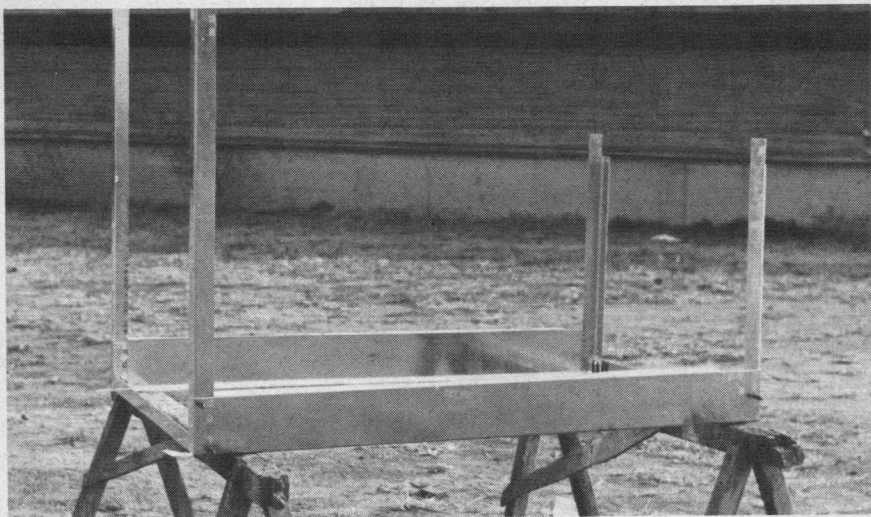
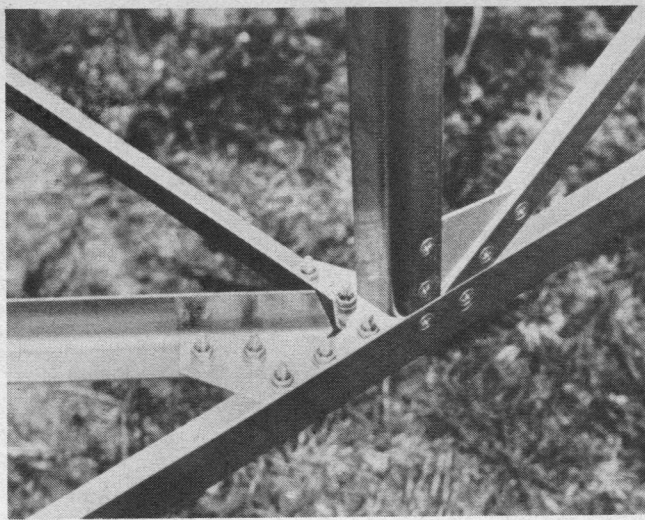
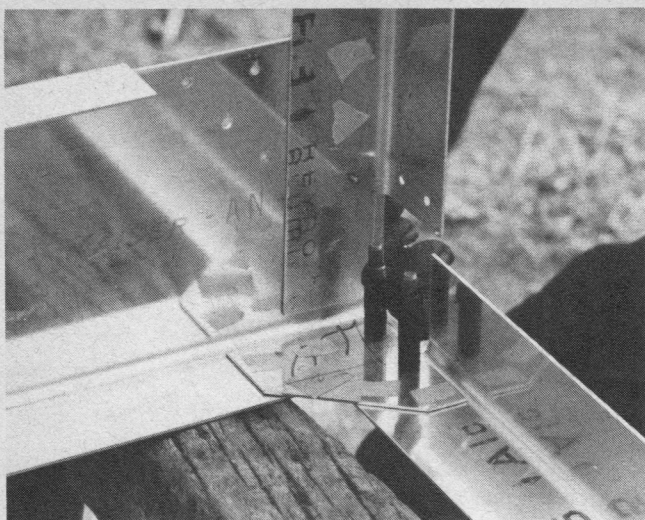
Obviously, Bede isn't going to make much money on the plans alone. He is pushing kit sales for all he's worth, but two thirds of the planholders either aren't building or are buying their goodies elsewhere.

Nevertheless, we found that most of the Los Angeles area builders whose airplanes were relatively far along have bought all or most of their material from Bede.

Two of them are Roger Lemburg of Garden Grove and Jim Murphy of Huntington Beach, neither of whom had ever built an airplane before. They both have their BD-4s skinned and on the gear with the tail section complete and engines (both new fuel-injected 160-hp Lycomings originally intended for the Wing Derringer twin) sitting in the garage ready for installation. Both men plan to build the wings last: Murphy hasn't ordered his panel ribs yet, and Lemburg's recently arrived.

Lemburg, who hasn't flown since he finished B-25 training just as World War II ended, has been at work a year and one-half already, and figures he has close to a year to go. He doesn't drive himself to work on the bird constantly. "My wife and kids are going to fly in this airplane," he explains, "and when I have an important part to work on, I just won't tackle it unless I feel rested and fit."

A salesman servicing garage and gas station accounts, Lemburg has a long mechanical background, but had never done sheet metal or riveting work. A pilot friend got him interested in a possible BD-4 project, and they bought the plans jointly. The friend hasn't gone any further, but Lemburg is glad he has. "I looked the plans over, and the



Bede innovations to homebuilding offer ease of construction. Good workmanship pays off in a safe, satisfying aircraft that flies the way Jim Bede intended it should.



As this BD-4 shapes up, the builder sees completion date ahead like a light at the end of a tunnel!

bug just bit me. I wanted to build it.

"I feel you do have to be somewhat of a mechanic to do a good job on the BD-4. It was a little scary at first when I looked at the plans, because I wasn't really able to read blueprints. I'm glad I was forced to read them, because I really learned how. But I think people do feel that this airplane probably is a little easier to build than it really is."

Lemburg has followed the blueprints fairly carefully, including the revisions and modifications which Bede supplies to all planholders. There have been more than 40 of these alterations to the original drawings, some of them major and absolutely vital to flight safety. "In fact, I had some of them applied before I ever got them from Bede," he said, "because I could see it wasn't quite up to snuff, some of it. So I went ahead and did some correcting, and lo and behold, here would come a sheet of paper with just about the same thing that I did. So I feel that I was a little bit ahead of him there."

One of the key modifications Bede has issued is to strengthen the fuselage members at the front and back of the cabin area on each side, which distribute the stress loads from the wing center section. These members originally were lengths of 90 degree aluminum angle which Bede repeatedly assured the public in written and spoken statements over a period of several years were adequately strong according to stress analysis. When a fuselage was finally tested to failure it was found that the stress analysis was wrong, as a good many homebuilders had always known it was, and Bede hurried out a mod which involved riveting a heavy-walled square aluminum tube inside each angle. Drawings and material for the fix have been supplied to builders without charge.

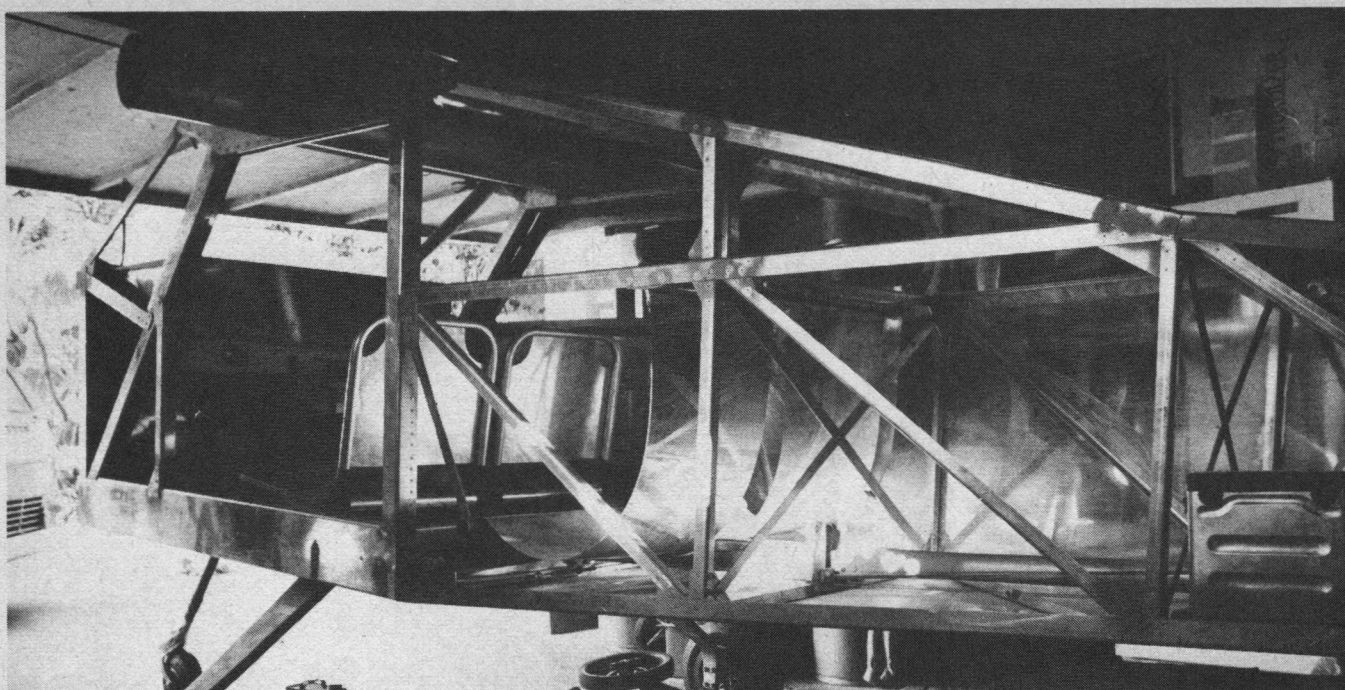
Among the Los Angeles area builders who still weren't

satisfied were Jim Murphy and Max Strboya. They were leery about the way the tubular center section spar was attached to the now-strengthened fuselage, with four bolts and a strap of aluminum under tension running across the top of the spar on each side. "The wing is plenty strong, and the revised fuselage is plenty strong, but I didn't care for the way they were hooked together," Strboya said.

He and Murphy both adopted a fix which other builders also are reported using. They made heavy flanges machined to the outside curvature of the tubular center section spar, and bolted them both to the spar and to the reinforced upper fuselage between the new support members. At the time of writing, Bede had issued no modification to the original drawings on this wing-to-fuselage connection.

The addition of the spar attach flanges is only one of the major areas in which Murphy has deviated from the blueprints. A machine shop manager, he has custom-made many parts of his airplane to his own designs, of much greater cost and complexity. "Jim Bede did a really first-class job of engineering this airplane for simplicity of building," he says, "but since I had access to shop machinery after hours, and this is my business, I wanted to do some things that the average builder couldn't be expected to do." For example, he machined special aluminum fittings at both ends of the push-pull tube which activates the all-flying tail. "They would cost about \$100 apiece if you bought them," he said. "They cost me a couple of bucks and a lot of time."

Murphy also revised the vertical tail, added a substantially larger dorsal fin and scrapped the half-rudder on the plans in favor of a full-length rudder of wider chord and much larger area. He built three rudders before he got the one he liked. He also fitted a reinforced aluminum floor under and behind the rear seats to support bigger baggage loads when



Simplicity of construction was major goal of Bede design, and BD-4 builders generally agree that Jim reached goal.

the sling-type seats are removed.

One reason Murphy has not yet ordered his molded fiberglass panel-rib wing components is that he isn't sure he wants to use them. "We've covered reams of paper making drawings of an all-metal wet wing," he explains. He has already built the ailerons and flaps as shown on the plans, and most of the design effort is aimed at a metal wing using the existing tubular spar. But he also has made studies involving a conventional I-beam type metal spar, since the stock Bede outer spars weigh 35 pounds apiece. "It is way overweight for the stress it has to bear," he says. "From the outboard tank section on out, there really isn't that much strain on the spar."

He also has toyed with the idea of bending dihedral into the spar center section and using the tubular spars themselves as fuel tanks, as is done on the BD-1-cum-Yankee. "But I suppose that if I had the money to order the standard Bede wing tomorrow, I'd do it," he admits. "I'm getting wary about re-doing earlier work or making changes, because if you get started on that you'll probably never finish the airplane. You know, I went to a meeting of the Huntington Beach EAA chapter recently and John Thorp gave a talk there. He's a very interesting person to listen to, and he hit me right between the eyes with a thing that I had started doing, and that was, don't start remaking parts when you get about half-done with your airplane, because you most likely won't ever finish it. Everything you do, you do better now than you did six months ago, so you keep making the same things over and over and each time they look better, so you never get to the end of the airplane. And here I was in the middle of a third rudder and a bunch of other things when he started talking about this. I decided he really did me a favor coming there to talk like that, because the next thing I was going to re-do was the tail cone, and instead of

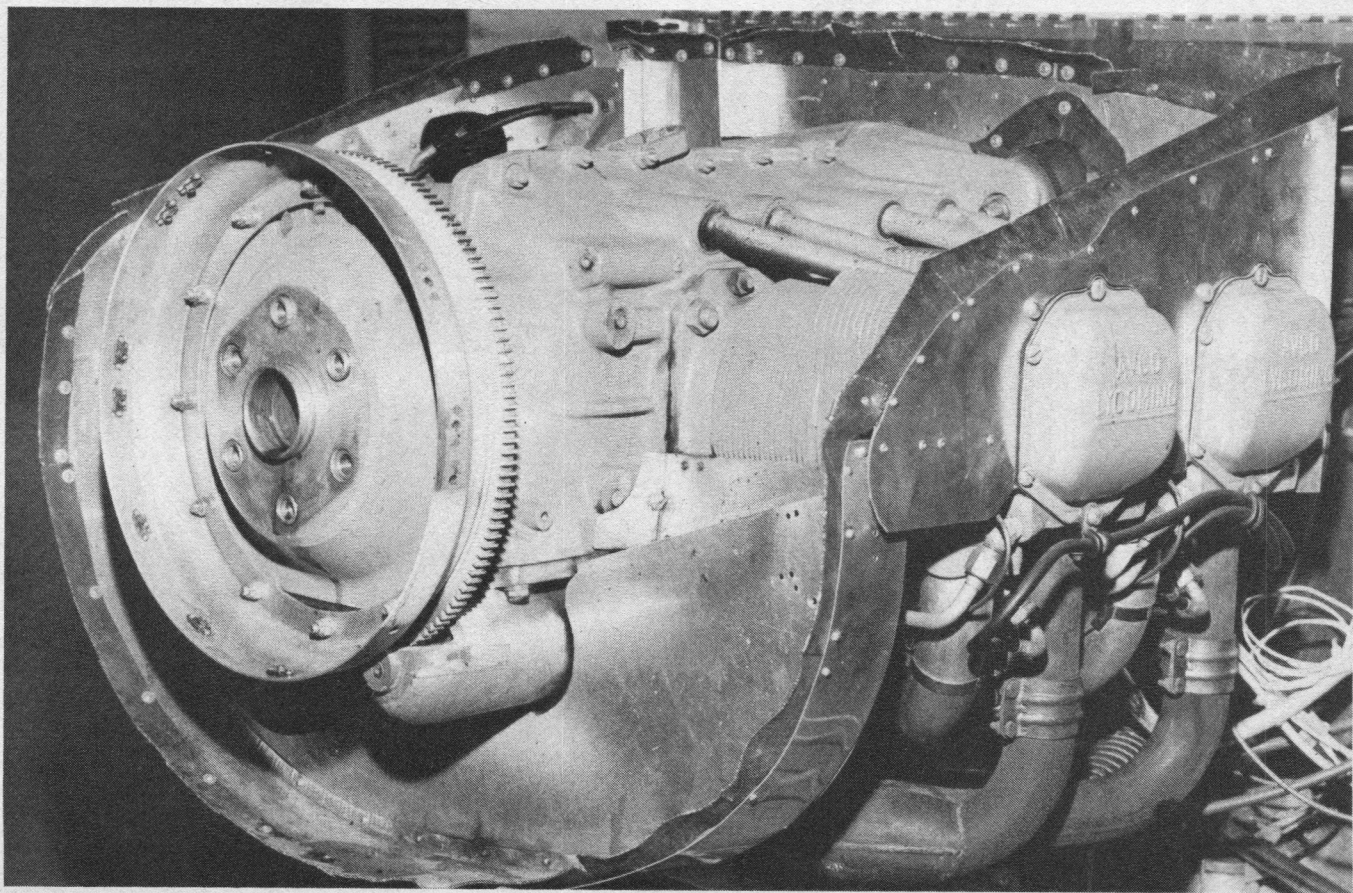
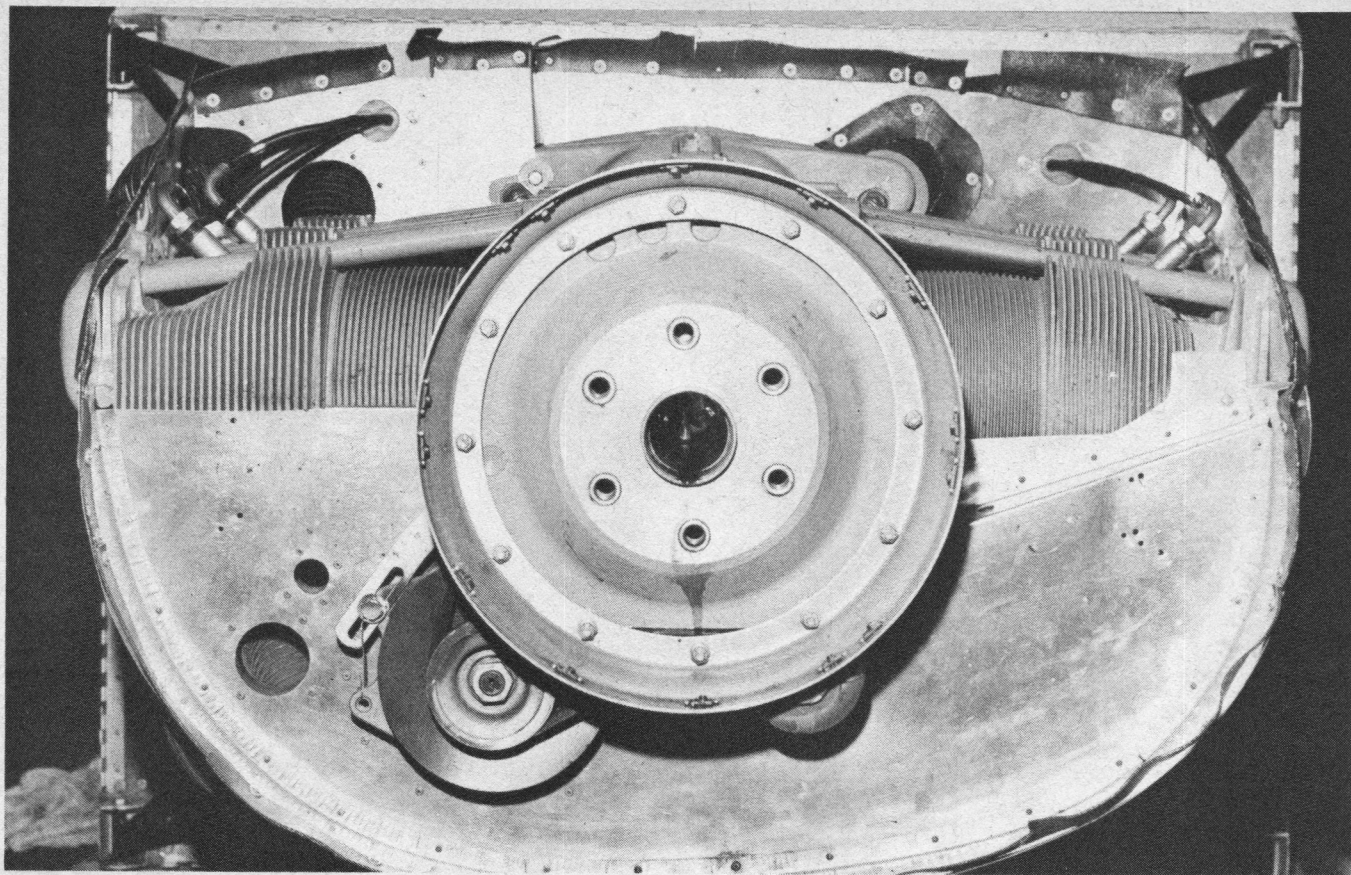
going forward I was going to start over again on all the little Mickey Mouse things I felt I'd done a bad job on. Now I'm just going to go ahead and build the airplane."

Murphy has worked about a year on the project, "with a lot of help," and feels he has about a year to go, "I think this airplane is 'way oversold, as far as ease of building is concerned," he says. "It's a long way from being a one-year, evening-and-weekend project."

On the subject of standard wings, Murphy said he had recently received a letter quoting a 60 to 90 day delay in delivery of the panel-ribs, which are available only from Bede. "But I've talked to some other people locally, and people were getting 60 to 90 day delay letters two years ago." We were advised by several builders that delivery of parts from Bede has been a continual headache from the beginning. However, all agreed that if several kits had been ordered, there was always enough material supplied to keep a builder plenty busy working on something else until the missing items arrived. And even builders who had been plagued by delays of many months on some orders agreed that when they did arrive, everything was first class. Blueprints themselves are generally agreed to be excellent, and all builders contacted were pleased with the fact that Bede continues to improve the design and correct defects, with corrections mailed promptly to planholders.

Bede readily admits that late-delivery problems have been real, but he reports they are all solved now. Shortly before press time a new warehouse operation went into service near Wichita, Kan. "We have that place jammed to the roof with every BD-4 part, and for the past 12 days we've been doing nothing but shipping back-orders," a company spokesman said. "From now on, orders will be filled as fast as they come in."

Tom August and Jim Murphy voiced comments similar to



BD-4 can carry any Lycoming engine from 108-hp to 200-hp, providing a wide range of performance figures.





those we heard from other BD-4 builders when they praised Bede's imaginative approach to a homebuilt design which offers both the load-carrying capacity and the performance of a production airplane, at one third to one half the cost. "There is tremendous utility value in this airplane," Murphy says. "I was originally attracted by the quoted performance, and it seems to stand up in the airplanes that are already flying. When you finish this airplane you have something that will really get up and go someplace."

Bede is continuing test and development work on the airplane, including static tests of the entire airframe. The company has announced plans to drop-test the landing gear, and to hire an independent firm to conduct aerodynamic flutter tests (which, on an airplane capable of 150-mph and up, depending on power, should be considered an absolute necessity). Bede already had developed a wing of wider span, a bigger vertical tail, a support behind the flat, sloping windshield to keep it from collapsing at high speeds, and other improvements. In his spare time he is reported working on a single-seat version of the airplane.

Other people are trying to improve it, too: Tom Cox of Acton, Calif., is working on a retractable landing gear for his BD-4, which is "pretty far along in construction," according to Glen Bennett. A pull-up gear on the BD-4 with a 180-hp engine would put the airplane within spitting distance of 200 mph, which is pretty good going indeed for a boxy little homebuilt that goes together not unlike a refined Erector set.

All in all, the BD-4 is judged by its builders to be quite a bird. No one knows yet how the radical structure will stand up to the kind of service that homebuilts normally see, but by the end of next summer it is possible that events will prove Jim Bede has finally produced something just about as good as he says it is. •

All of Jim Bede's aviation activities have been announced publicly with great confidence long before actual flight did (or did not) take place, and the BD-4 Bede-bird is no exception. Only weeks after the first customer-built BD-4 took to the air, Bede announced the impending arrival on the scene of the BD-5 Micro, a single-seat sports plane with a pusher prop in the extreme tail driven by what Bede coyly describes as "a low-maintenance, compact engine of foreign manufacture." It features fully retractable tricycle gear, wings in two size options, and a choice of power ranges.

But the most significant thing about the BD-5 was the way it was to be sold. Bede, apparently having decided that too many BD-4 builders were spending their money elsewhere for materials, arranged it so that if you want to build the Micro, you pay Jim Bede. No plans will be sold separately, but Bede will supply complete material kits which will be accompanied by assembly instructions and drawings. "Many parts to be included in a materials package to build the Micro will represent new ideas in aircraft construction, and will be available only from Bede Aircraft, Inc., Newton, Kan. 67114," the designer said.

Bede described the Micro as being "so unusual in both construction and general principle that it will certainly surprise many in the General Aviation industry."



Jeanie's Teenie



IN MAY, 1968, the editors of Popular Mechanics offered their one and one-half million readers a tantalizing build-it-yourself airplane article about a minuscule, minimum structure single-seater called Jeanie's Teenie. Like Henri Mignet's celebrated Flying Flea of the mid-thirties, Jeanie captured the imaginations of flying enthusiasts by the thousands. Its uniquely simple all-metal construction appealed especially to non-pilots eager to get into the air on a small budget. The materials for the prototype, including the 36-hp Volkswagen engine and all accessories, had cost the designer, Calvin Y. Parker, just \$600. Parker says Popular Mechanics sold 7,000 sets of construction drawings (at \$15 per) and J.T.s began taking shape in home workshops around the world.

Even before the second J.T. got off the ground, however, rumors were rampant that there were certain inherent defects in the design. Detractors insisted that it was too small to be either safe or practical. The controls were reported to be so sensitive that the airplane was virtually unmanageable. Thousands read in a leading flying magazine

an allegation that J.T.s were prone to collapse on the runway. It was largely a one-sided affair, with little being heard from designer Calvin Parker by way of rebuttal. The controversy grew month after month.

We decided not to beat around the bush and asked Parker about the rumored rash of crack-ups. Parker replied that he knew of five accidents, one fatal. In each case the airplane had been modified to some degree. One builder had installed a 75-hp Continental which was totally incompatible with the airframe. "That one got pranged on the first flight," said Parker. "We have tried to get the point across that Jeanie's Teenie was designed around the VW engine, but somebody always wants to put in more power. John Thorp (T-18) and Volmer Jensen (VJ-22 Sportsman) have to contend with the same situation. When you double the horsepower you're inviting trouble."

Parker continued, "a boy was killed in a modified Teenie. He had rigged up an anti-servo tab to give the elevator more power and feel. It was his first flight and I don't believe he had much experience. Apparently the airplane was handling

satisfactorily because he flew away from the airport. A little later he stalled on a steep pull-up and spun in. The original Teenie doesn't stall like that. It sinks fast, but with full aileron control. You have to force it to spin and it recovers in half a turn. But when you start changing the plans and adding weight, the whole character of the airplane can change.

"That's what makes us so angry," Parker lamented. "People go out and buy a set of plans and then right away they incorporate ideas of their own. Sometimes it's an improvement, but most often you sacrifice something. One man showed up at Oshkosh with a highly modified version of the J.T. that looked like a racer. It had a tail wheel, Wittman gear and a canopy, but everyone knew where the rest of the design had come from. Fortunately for all concerned, it seemed to fly very well. Of course, he didn't call it a Jeanie's Teenie, but I'm sure we would have taken the blame and bad publicity if it hadn't worked out. It's unfair to the designer when people start tampering with the plans and make unauthorized changes."

There have been several published accounts of J.T. nose gear failures. Parker insists that there is nothing wrong with the design and that problems arise only after improper materials have been used or the welding is bad. "We ran 60 or 70 fast taxi tests over rough ground," he told us, "and never had a problem. You can go out and knock the landing gear off any airplane, but that's just plain bad technique. Remember how rough it was at Oshkosh? There were three or four landing gear failures on the grass. I flew the whole week and didn't have a bit of trouble. My back was sore for a while, but the landing gear came through in fine shape."

We questioned Parker about the nose gear failure on the original airplane. According to one report, the pilot was taxiing at high speed when the VW 1500 shed its propeller. It veered off the runway and into the grass, at which point the nose gear collapsed. "That's not quite how it happened," Parker declared. "Witnesses tell me it was dropped in from 30 feet when the propeller came off. The new owner had made an engine change and the hub cracked because someone had done a sloppy job cutting the keyway."

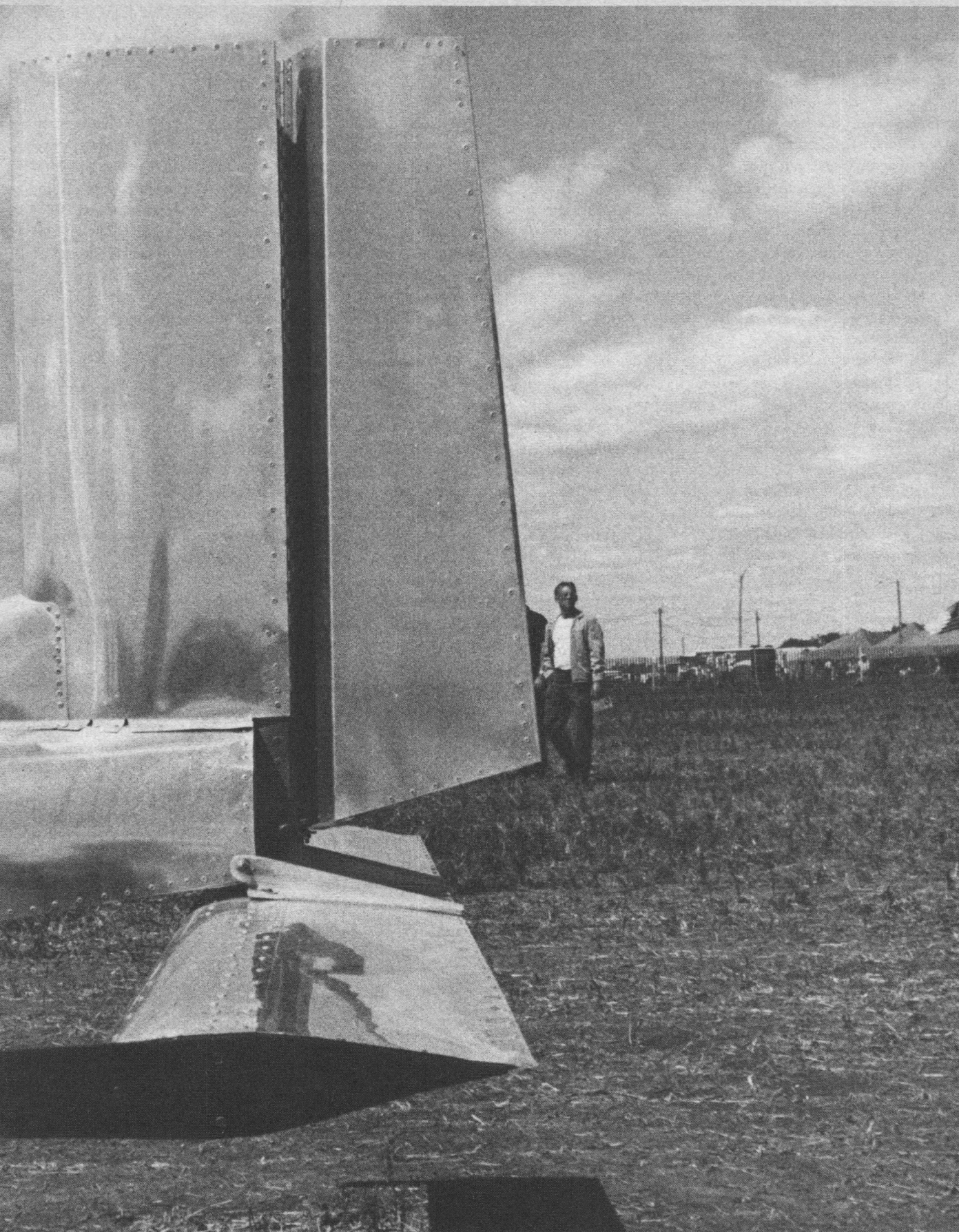
Had there been other nose gear failures?

"Yes, one or two," Parker replied. "A man up in New Hampshire had some trouble. I asked him to send us the parts for inspection, but he didn't. It could be that the materials were sub-standard or the workmanship was defective."

Calvin Parker readily concedes that Jeanie's Teenie is not a beginner's airplane. On the other hand, he says there is no reason why it can not be flown safely by low-time pilots who have been properly briefed beforehand. Dr. H.E. Bartee, who made the initial test hop in the J.T.2, had a son, Tommy, age 16. Tommy was a student pilot with 30 hours in Cessnas when he checked out in the J.T. 2. The flight was uneventful and proves that long experience is not necessarily a prerequisite to flying a J.T. It is a minimum power airplane; that is to say it uses the least amount of power necessary for practical flying. There is not much reserve power and little margin for error.



Rugged, clean, all-metal tail design of the Teenie is evident in this photo of a well-built machine.



Jeanie's Teenie has extremely sensitive controls by American standards (Europeans tend to prefer lighter controls with more response). When flying the J.T. for the first time one must keep in mind that a small displacement of the stick in any direction is going to produce a rapid response. The offset stick has only 1½ inches of travel on either side of neutral, but you use only a little aileron. Likewise, you need but little fore and aft movement to obtain the desired result. Remember, too, that the application of excessive back pressure on takeoff will cause Jeanie to rock back on her tail. If there is flying speed, she will leap off the runway in an alarming attitude. The natural reaction is to pop the stick forward, in which case a bit of porpoising may ensue. One learns quickly to go light on the controls, which is the way many of us like to fly anyway.

The question of cost has been the subject of heated debate. Parker claims that his JT-1 is the cheapest airplane you can build and that it can be done for \$650 or less. Many builders say Parker's estimate is unrealistic. Paul Kratky spent \$1,800 on his JT-1, but this included two different engine installations. VW engines in the 36-to-50-hp range can be picked up for as little as \$100, but conversion will run between \$200 and \$300. If you want to go first class, a brand new zero-time VW conversion from Revmaster (Riverside, Calif.) or Ted Barker Engines (Palomar, Calif.) will cost you between \$795 and \$1,250. It is generally agreed that the raw materials for a JT — sheet metal, extruded angle, tubing, pop rivets, etc. — can be obtained for \$300 or less. Miscellaneous items such as instruments, wheels and tires, welding and machining will run another \$175 to \$200. We heard of one resourceful soul who completed a JT for less than \$400. Others have kept their cash outlays down to \$550, but we suspect the average builder will spend something on the order of \$800 for his Teenie.

Parker's performance claims have been challenged on more than one occasion. It has been asserted in print that the 36-hp JT climbs at about 300 fpm instead of the advertised 800 to 1,000 fpm. Parker contends that the prototype performance figures are accurate and that dissatisfied

builders have only themselves to blame. "We can't insure uniform construction," he told us, "and that's the main problem. Some J.T.s are coming out 50 to 100 pounds overweight. That cuts into the performance more than anything."

Another problem area is the propeller. There have been several cases where JTs refused to fly because they were swinging the wrong propeller. In a minimum power airplane this is a vital point. Parker says that the 50-inch Hegy propeller with 40-inch pitch has given the greatest satisfaction on the 53-hp JT2. His performance figures list an 800 fpm climb and a cruising speed of 110 mph at 75 percent power. At the present time, Parker's airplane is fitted with an experimental Troyer aluminum propeller which he claims has given 1,500 fpm climb without sacrificing cruise performance.

There have been numerous complaints that the JT2 plans are sub-standard and that builders have difficulty getting answers to their questions. Parker contends that many amateur planemakers won't take the time to study the plans, and he figures it takes several hours each day to answer questions. One builder has called him almost every day for months to ask him something. After spending an evening studying the plans and instruction booklet, we could understand why: we'll have to side with the complaints and agree the drawings leave much to be desired. Parker admits in the instruction booklet that he left some things "deliberately vague," to insure that builders would learn how to solve problems. But the JT2 drawings are vague to the point of asking more questions than they answer. An experienced builder probably could figure them out, but the neophyte — to whom an airplane like the Teenie has the most appeal — is likely to have trouble. Parker considers the \$35 (formerly \$75) price as primarily a license fee to build the Teenie, but buyers may tend to regard it more as payment for a set of useable blueprints.

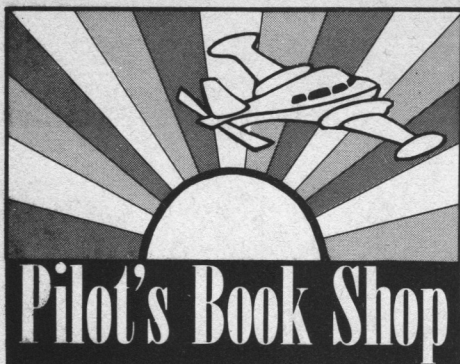
There can be no doubt that the Teenie has wide appeal as a low-cost sports plane with fewer parts and less structural complexity than just about anything in the air. •



Cal Parker and his J.T. prototype N2861 win admiration wherever they appear at EAA homebuilt fly-ins.



Offset control stick is sensitive to handle, pilots say, but then you're not supposed to wrestle with Jeanie!



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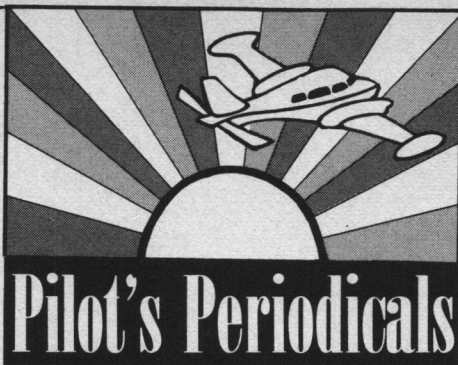
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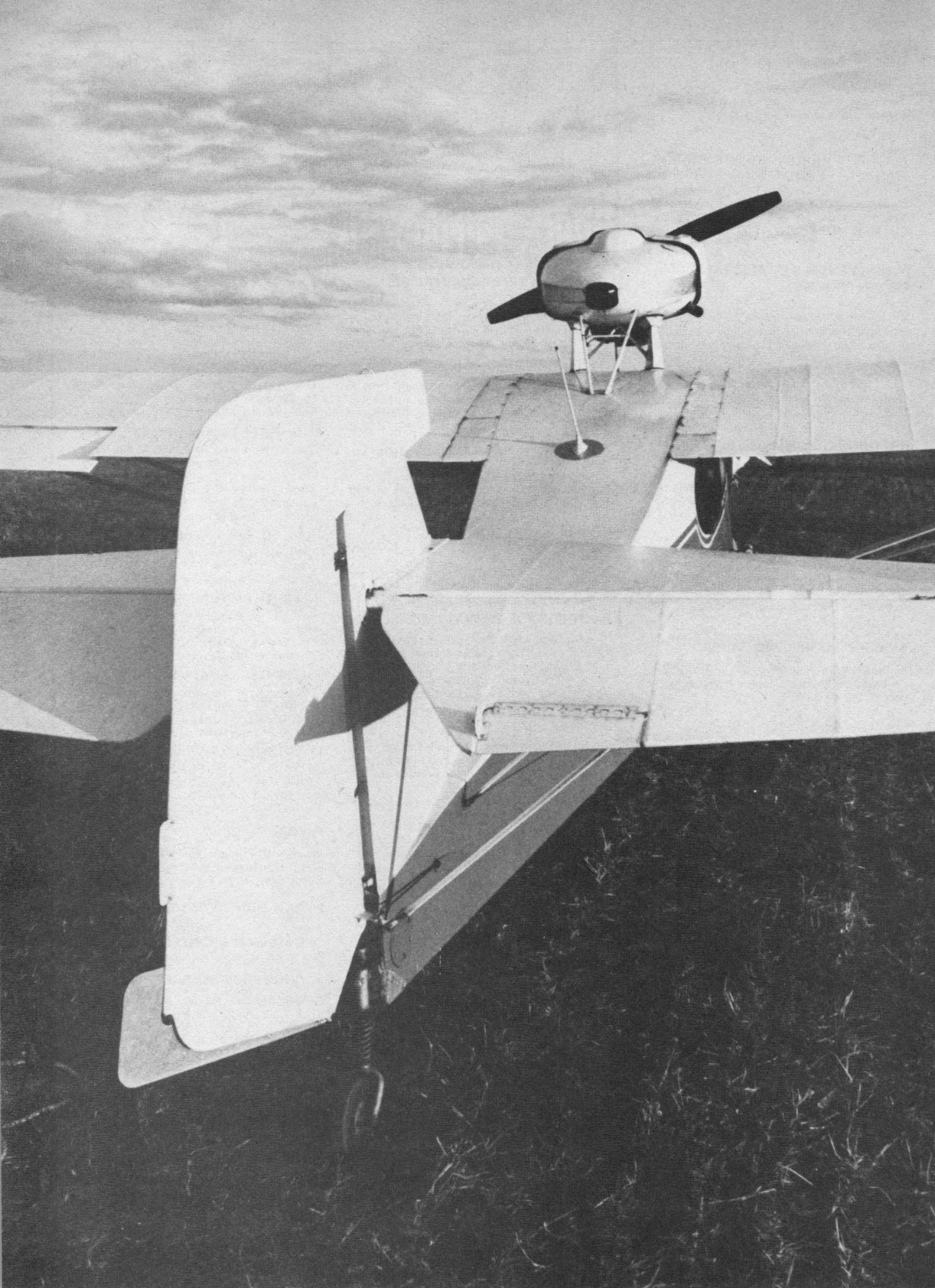
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Anderson Kingfisher



BUILDING YOUR OWN airplane in your garage or basement has several drawbacks: you have to spend many months at work before you can go flying; it usually costs more than you thought it would, and your wife probably will complain that you never take her to the movies any more.

But to set against these drawbacks there is one very positive advantage: when you build it yourself, you can get exactly what you want.

What Earl Anderson wanted was a fun airplane in which he could go fishing at moderate cost. The Kingfisher is his answer, and it may be yours.

Waterplanes have been sparsely represented in the homebuilt stable for many years. For the past decade Volmer Jensen's popular VJ-22 Sportsman has ruled the amphibian roost virtually alone. But in the past few years two planes have flown enough to prove themselves definite

contenders for the webfooted homebuilt market: the Spencer Amphibian Air Car and the Kingfisher. Anderson credits Jensen's highly popular pusher-engine flying boat with getting him started on the ideas for his own design.

There are a number of similarities between the Sportsman and Kingfisher. In dimensions and performance the two airplanes are virtually the same. Both use wings from production airplanes, Aeronca Chief or Champ for the Sportsman and J-3 Cub for the Kingfisher. Both use the 100-hp Continental O-200 engine. General structural technique is similar, with the fuselage built of spruce longerons and braces with mahogany plywood skin and an overall covering of light fiberglass to keep the hull watertight.

Significant differences are found in the choice of pusher and tractor engine mounting. In the Kingfisher, Anderson chose a tractor installation for several reasons. "In addition



Tractor engine mount places the engine high.

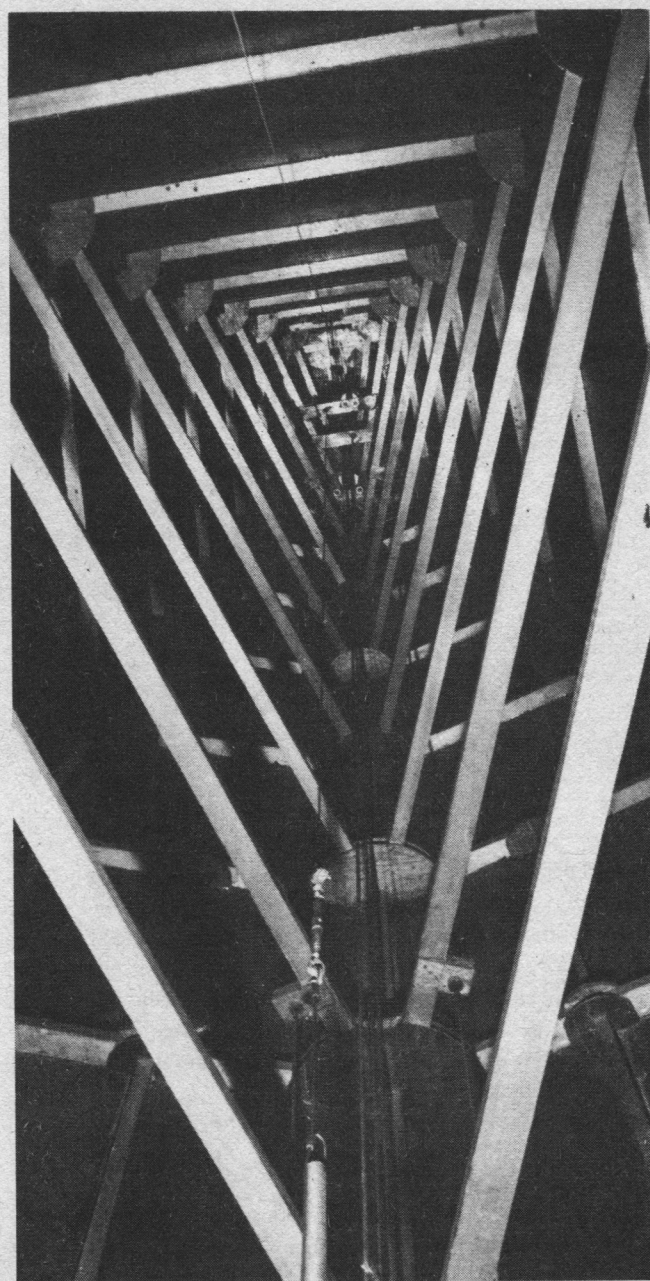
to increased efficiency and safety," he says, "an important reason for the location of the engine is for easier building. The engine mounts on its proper mounting pads. The cooling, induction and exhaust systems are standard off-the-shelf items. The installation also eliminates propeller damage from loose screws, etc., flying back into a pusher prop. Furthermore, there is no necessity to have the propeller custom-made, as in a pusher."

The heart of the Kingfisher structure is a pair of robust bulkheads at the front and back of the cabin area. Built of wood and heavily reinforced, they serve as attach points for the front and rear wing spars, the struts, front and rear engine mounts and the landing gear. The gear is similar to that used in the Sportsman, with one steel tube sliding inside another and wrapped with shock cord at the top to absorb landing stresses. But where the Sportsman gear is mounted on a through-the-hull tube which pivots to raise or lower both wheels at once, the Kingfisher's gear is independently operated. Separate spring-loaded levers adjacent to each wall of the cockpit are manually swung up or down and locked in place to cycle the gear.

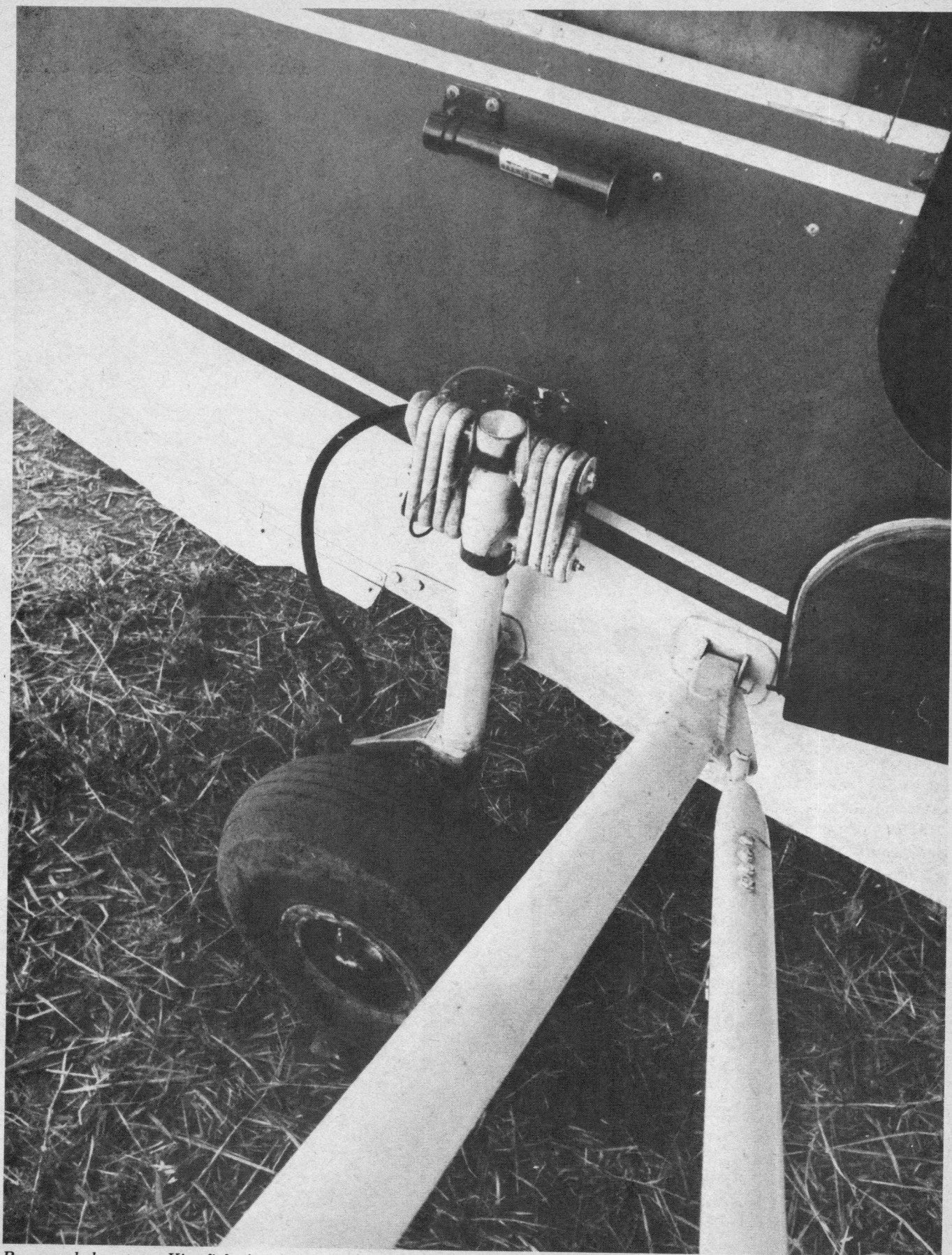
Entry to the Kingfisher cockpit is through a left-side door, and because the cockpit is positioned beneath the wing, getting in and out is a bit awkward. Once seated, visibility is about what it is in a Cub, and the wing goes down to obscure vision into turns.

The panel arrangement is relatively uncommon. Since there had to be a hefty bulkhead at the front of the cockpit with a massive overhead member running across to serve as the primary engine support, it was logical to install power controls up where they would have a short, straight run to the engine. As a result the Kingfisher has the overhead panel common to many seaplanes but not often seen in homebuilts. Throttle, mixture, carb heat and starter are mounted overhead, together with all engine instruments except the ammeter. This leaves the lower panel clear for altimeter, airspeed, needle and ball, compass and a small luxury — the rate-of-climb indicator.

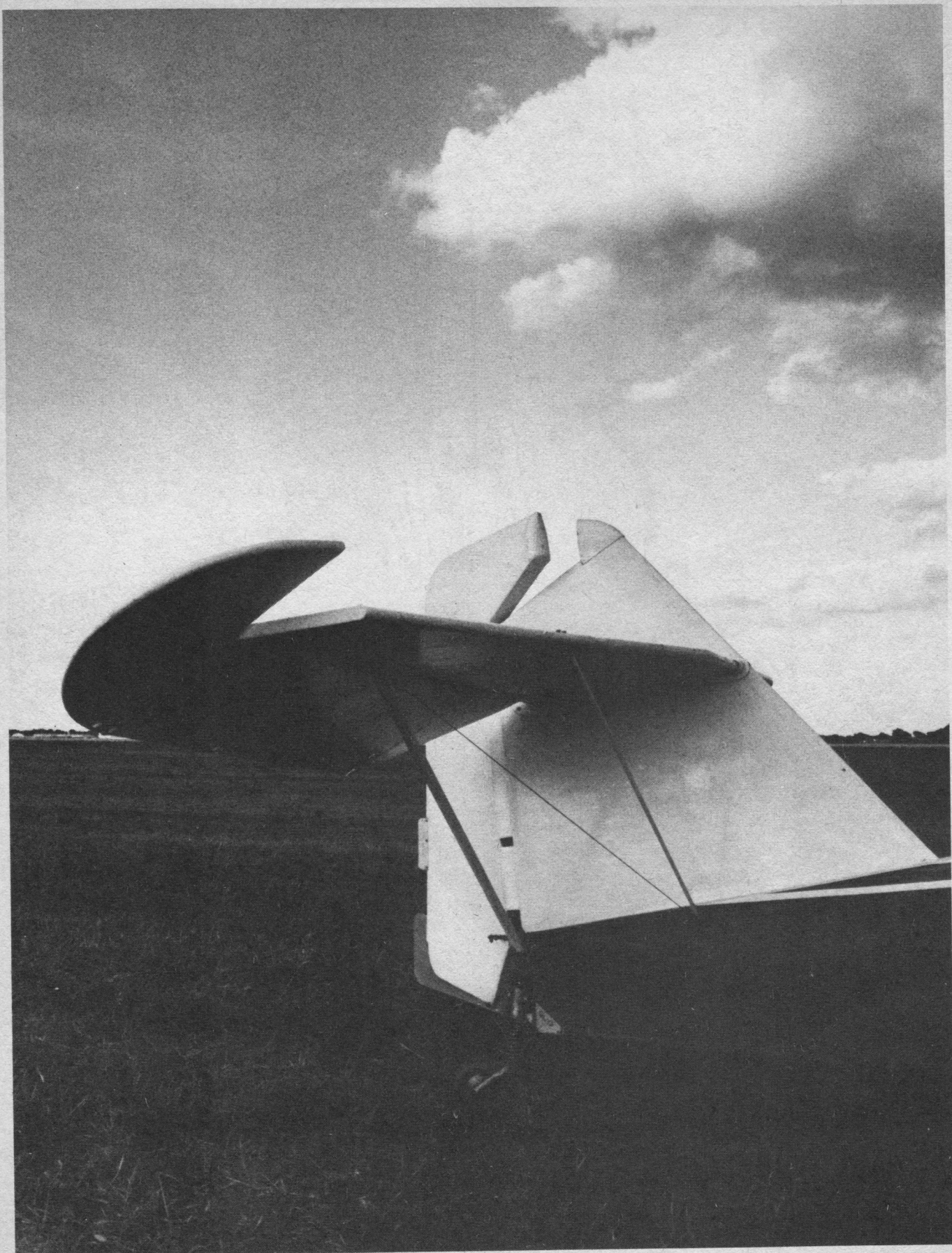
Since the 20-gallon fuel tank is located just ahead of the windshield, the lower panel also provides a convenient mounting for the primer plunger and electric fuel pump switch, which must be on for all takeoffs and landings since the engine is a long way above its fuel source.



Simplified triangular shape of main hull makes Kingfisher an easy-to-build aircraft.



*Bungees help retract Kingfisher's gear
for water landings with minimum of fuss.*



High-mounted stabilizer keeps tail out of the water when the salt spray flies.

The center-mounted overhead throttle is fitted with a small rubber wheel which can be — and should be — moved up or down whenever the wheels go up or down, so that as the pilot hangs his hand on the pendant T-handle he gets a tactile reminder of where his wheels are. In addition, the one on his side is in easy view.

Designer Anderson is a veteran Pan American captain with some 25,000 hours in his logbook, a good deal of it in lightplanes. "I have owned many airplanes, beginning with a J-2 Cub and a Curtiss Wright Junior pusher and going on up to a 180-hp Apache twin," he said. "These airplanes only offered a ride from one airport coffee shop to another, at great expense. The Kingfisher can take me where I really want to go — fishing — and to scenic beaches. It is versatile: you can land in your favorite lake, shut the engine off and swim from the airplane, or you can put the wheels down and taxi up onto the beach."

Anderson invited me to fly the left seat and I promptly accepted, confident that with full controls except brakes on his side, a 25,000 hour ATP ought to be able to keep me out of trouble. Happily, I didn't need help, because the Kingfisher turned out to be surprisingly easy to handle. It isn't even hard to cope with on the ground heel brakes and all.

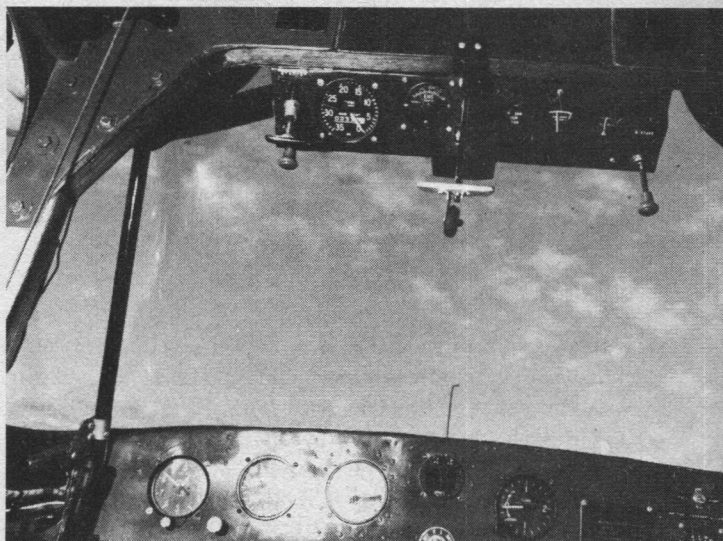
In the takeoff roll on the runway it takes a bit more to get the Kingfisher's tail up than it does with a Cub, but visibility over the nose is no problem even three-point, and since the non-steerable tail wheel can — and should — be locked straight, there isn't much difficulty with directional control. Acceleration is no more fantastic than it is in any other airplane using this engine. I found the takeoff and climbout just about the same as the Sportsman. The tail was up in seven seconds and we were off the ground in 11 by my stop-

watch, with full fuel and very close to allowable gross of 1,500 pounds.

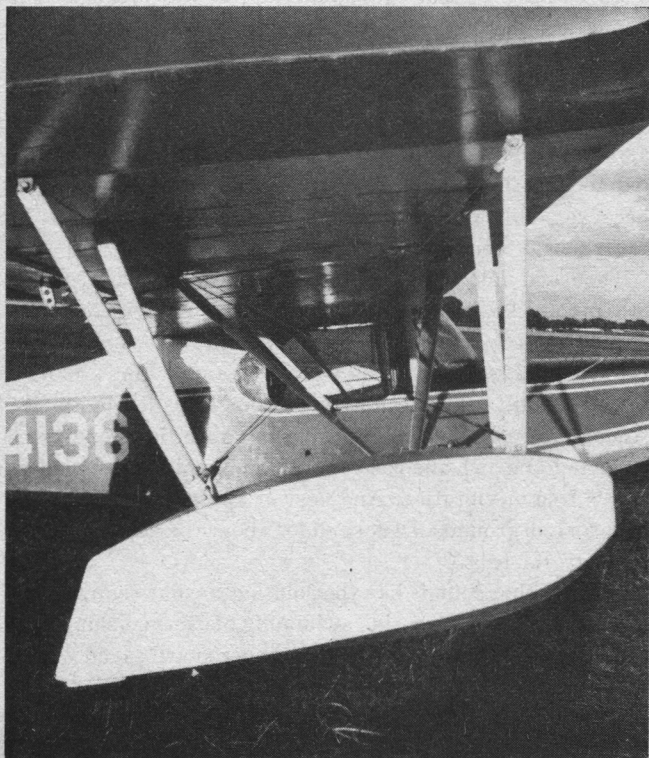
The specs call for a max rate of climb of 550 fpm but for me the dial showed just a shade under 500 at 60 mph going out of Wittman Field on a warm summer day, and I'll be satisfied with that any time.

In the air the Kingfisher is fairly noisy, since you sit right below the engine and the prop disc is just 17 inches ahead of the windshield. Anderson installed a Tri-Pacer windshield and he says a rounder shape might lessen the noise caused by high-velocity prop blast impacting against the plexiglass.

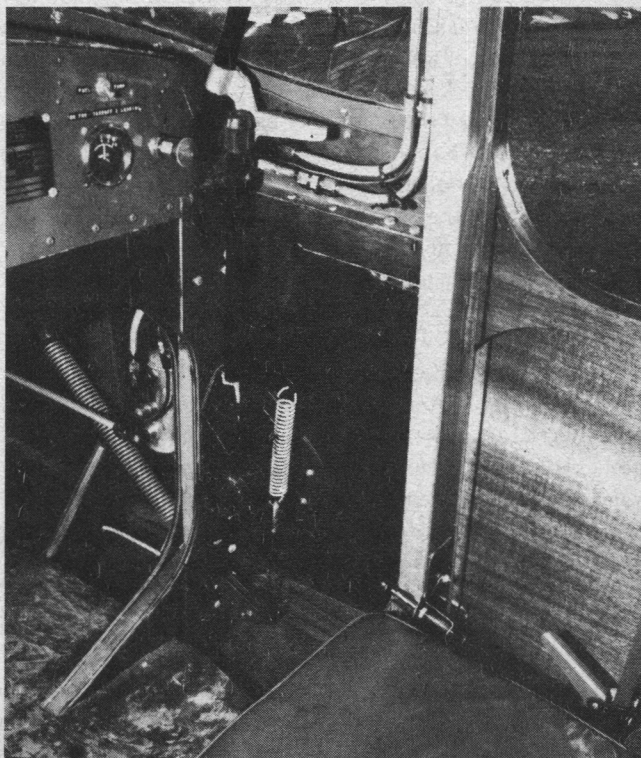
A trim tab is installed on the right elevator of the



Overhead location of power controls simplifies hookup to engine on pylon.



Tip floats prove stable in radical step turns; rugged with wire bracing.



Spring-loaded wheel control gives pilot more sensitive handling in landings.



Anderson Kingfisher (front) compares well with popular Volmer Sportsman VJ-22 (rear).

prototype, but isn't connected to anything, since Anderson found that stick forces were light enough under all circumstances that he could dispense with the trim mechanism. I found it no strain at all to overpower mild out-of-trim in climb and landing with just a trifle of stick pressure. In several trips to the lake on two different days I repeatedly got the Kingfisher to show 83 to 85 mph cruise speed readings.

But the real name of this game, and the reason for Anderson's enthusiasm for the airplane, is water landings. What a blast! Carb heat and fuel pump on, power back, a check to make triple-sure the wheels are up, and down we go for my first one, keeping the speed up and the nose down until it seemed like the seat of my pants was about to run on the water. The Kingfisher goes on best in a fairly flat attitude, and when the keel touched at the step we could hear it slapping the water gently but could hardly feel it. Then there was a firm, steady declaration with no tendency to pitch nose-down, and there we were. That landing drew a compliment from Capt. Anderson — it was the last one I got in two sessions of water landings with him.

On the water, a between-the-seats lever lowers the water rudder for better steering, and an unusual arrangement is employed to fold the tailwheel up to the left 90 degrees to get it out of the water. The Kingfisher step-taxis and turns very solidly, and even at fair speeds you can throw in hard aileron, stick a float down in the water, and skid-turn right around it in a surprisingly small radius. The floats are strut-mounted, wire-braced flotation cells of spruce frames, plywood and fiberglass.

On my first couple of takeoffs I had so much water on the windshield for the first 10 seconds or so that I couldn't see a thing, and the runs seemed unduly long. Capt. Anderson did one with no water on the windshield and we were off with water in 25 seconds. It turned out that I was holding too much back pressure to get the nose up on the bow wave, and

subsequent efforts were much better.

The propensity of the Cub wing to fly slow almost proved my undoing on a couple of landings. There is a tendency to try to slow the airplane up and flare in, instead of carrying speed right on down until you level out inches above the water. Seaplanes will bounce just as high as a Cub will, if you drop them in from two feet up, and they tend to make a lot more noise in the process. The Kingfisher's hull is some five inches narrower than the Sportsman's, and there is more angle to its V-bottom hull, as a result of which it seems to pound less in rough water or on hard touchdowns, and to take a trifle longer to get all the way up on the step on takeoff.

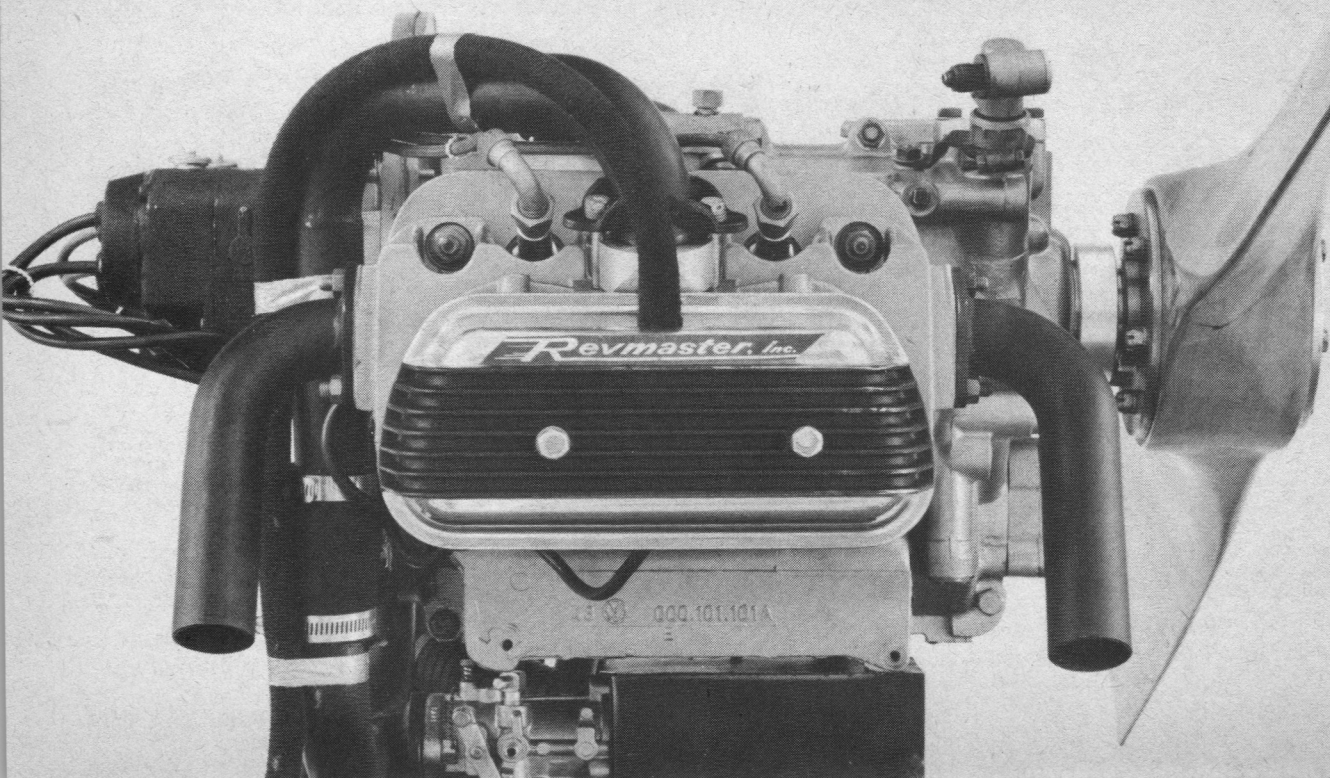
In the air, it feels like a Cub. I stalled it a couple of times and there doesn't seem to be much bite. But to be truthful I did not put the airplane through the whole series of stalls, because who wants to waste time stalling around when he can shoot water touch-and-goes?

Thousand-mile cross-country trips in this airplane, or any other one like it, would get tedious, what with 85 mph speeds and gas stops every 300 miles. But that isn't what it is for: it's for getting out on weekends and having a ball. "I can truthfully say I am more than satisfied with it," Anderson says. "While the performance is modest, as expected, the airplane has easy and pleasant flying qualities and is free of vibration. And best of all, it is economical — you can tool around all weekend for about the same gas as in a water ski boat."

If Kingfisher sounds like the solution to your requirement for a two-place side-by-side swimming platform/fishing boat that can fly to where the action is, Anderson will send you an information packet for \$2 or construction plans for \$100. Plans are on 16 sheets 30 by 48 inches or larger, and include full-size templates for each frame, material lists, sources of supply and other useful data. Write him at 41 Sunnyside Road, Mahwah, N.J. 07430. ●



High tractor mounting of Kingfisher engine puts the power up where it does most good.



Revmaster Volks Conversion

THE RAPID EXPANSION of the homebuilt movement during the past decade, coupled with the normal wear and tear of operation over the years, has brought homebuilders face to face with a fairly pressing problem: we are beginning to run out of engines.

Certified aircraft engines for homebuilts, particularly those on the lower end of the power range, are for the most part old engines, not manufactured in recent years. The large supply of converted ground power units left over from World War II, which were such a rich source of engines in the decades immediately following the war are growing much more scarce. As the smaller 65 and 85-hp aero engines from the 'Thirties and 'Forties began to wear out, and the cost of the few remaining ground power units climbs out of reach, more and more homebuilders are beginning to scratch their heads and wonder what they're going to put into the bird once they get it built.

Of all the possible answers to that question, perhaps the most promising is the development of aircraft conversions of various automotive engines. And of the automotive types that have been tried in recent years, the one which seems to offer the most potential for small, light aircraft is the ubiquitous Volkswagen engine. It is the right size and shape, it is an air-cooled engine, and — best of all — it is available in large and growing numbers at prices well below those of aircraft engines with similar power potential. And while the rising tide of VW imports may cause grave distress in Detroit, it can do nothing but please the homebuilder, who sees in this invasion of beetles a continuous resupply of his stock of potential homebuilt powerplants.

There is, however, as there usually is — a fly in the ointment. The VW engine turns too fast for a propeller. It generates its rated power at revolutions well above 3,000, in ranges where propellers simply are not efficient. Therefore, to make use of the shining potential of this vast supply of engines, someone had to figure out how to get the power out of a VW engine while it was turning at substantially less than its rated rpm. And somebody has.

The first and most obvious way of doing this is to utilize a reduction drive. Some designers have done this by developing gear boxes, and others have utilized belt-drive arrangements, either of which serves to reduce the rpm of the prop shaft while allowing the engine to turn at much higher revolutions to develop rated power. But it takes considerable

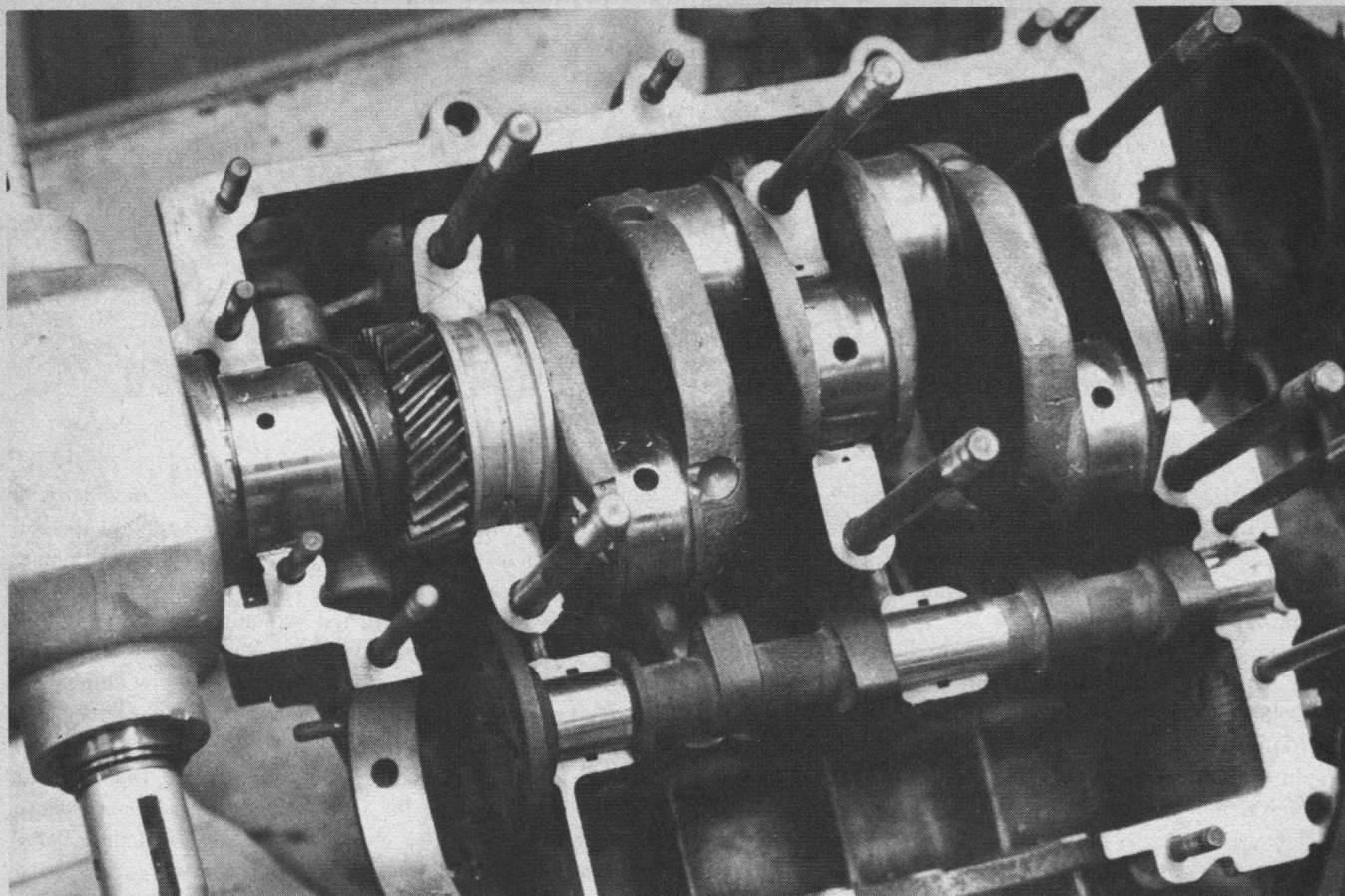
doing to develop a small, light, low-cost gearbox which will stand the gaff while turning at 3,500 or 3,800 rpm on one end and 2,500 or 2,700 rpm on the other end. And not all homebuilders are overjoyed at the idea of depending upon a propeller which is being turned by belts. So more and more people began to wonder whether it would be possible, with various modifications, to generate acceptable power levels in the Volkswagen engine while turning it at revolutions which could be used by propellers.

Now an aircraft engine is nothing more than a heat machine — a device for converting thermal energy into mechanical energy. An engine with a specified piston displacement, turning at a specified rpm, will generate a specified amount of power. To get more power with smaller piston displacement, the engine must turn faster. But the VW already turns too fast for efficient propeller application, so the problem becomes one of achieving the same amount of power at a lower rpm. The way — the only way — to achieve this is to increase piston displacement. This is the path that has been followed by the developers of the Revmaster W conversion for aircraft.

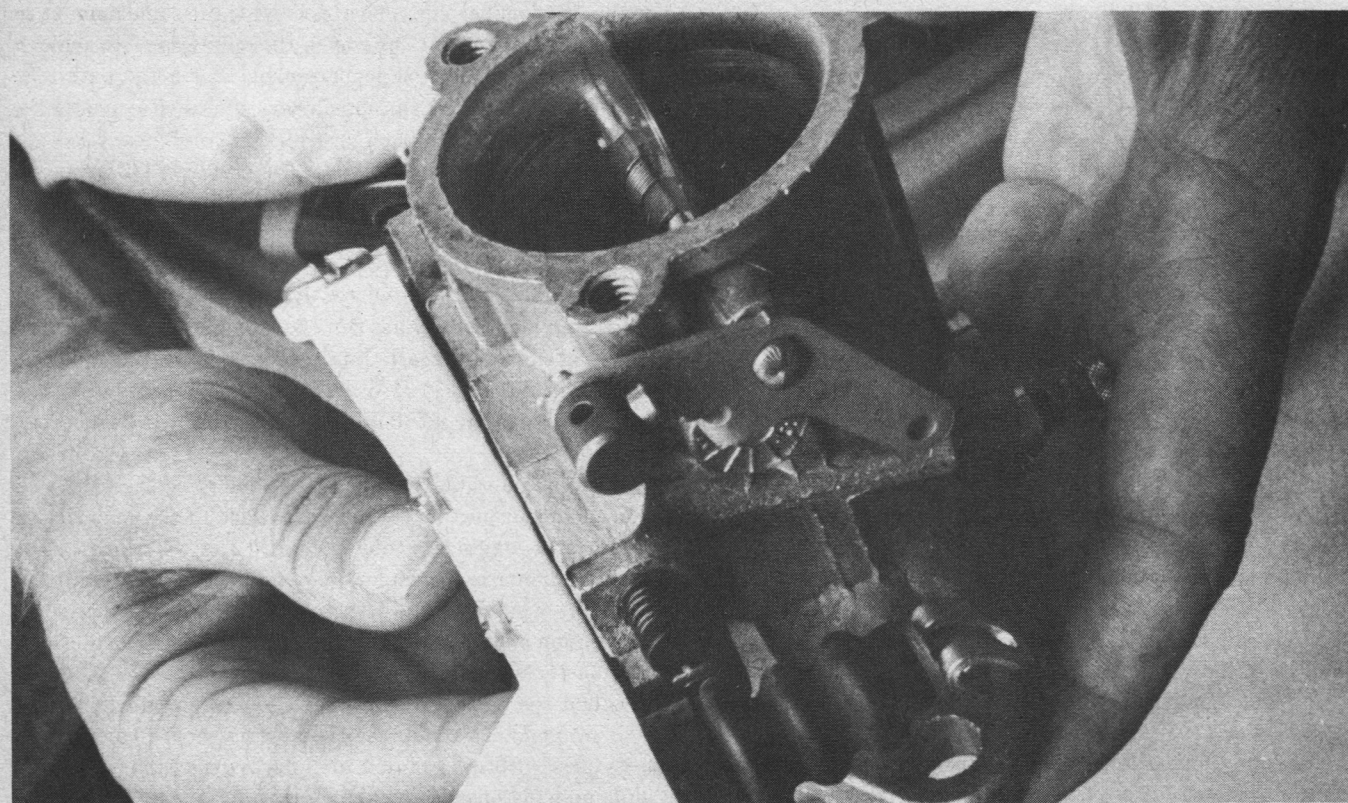
Revmaster, headquartered in Riverside, Calif., has for some years specialized in the modification of Volkswagen engines for use in off-the-road vehicles, dune buggies and racers. They have developed "Baja" engines that turn as high as 6,000 rpm, and currently are campaigning a strip dragster which already has run 130 mph in the quarter-mile, and is designed to reach 150. The engine in this vehicle, which started life as a VW but bears little relation to one now, develops about 350 hp, according to Revmaster spokesmen.

With innumerable 100-hp VWs to their credit in the past and a monster putting out more than 300 hp on the dragster, Revmaster engineers did not feel that working up a satisfactory aircraft conversion would be all that difficult. Basically what they did was to take a well proven 100-hp conversion and derate it to 65 hp, add dual ignition and fit a Revmaster-designed propeller hub.

Called the 2100-D Powerhaus, the engine starts with a Volkswagen 1500 crankcase. The cylinders are replaced by new ones with deeper fins for improving cooling. Die-cast aluminum pistons also will be offered, for a weight saving of about 13 pounds when the engine is all set up. The stroke is changed from 69 to 78 millimeters and the bore from 85 to



Revmaster has developed a constant-speed propeller shown attached to shaft of the dual-ignition conversion.



White plastic casing on the special Tillotson floatless carb contains an accelerator pump for instant power.



Revmaster bought a Fournier RF-4 for use as a flying test bed for 2100D and future VW engines of higher power.

92, and this increase in displacement is the biggest reason why it is possible to pull 65-hp out of this engine at half, or less than half, of the rpm required for the same power output in a stock automotive VW.

Revmaster makes its own heads for the dual ignition set-up, which involves drilling through the valve chamber to allow the second plug to be mounted at the proper angle.

The problem of hooking a prop onto a VW crankshaft has been handled in a number of ways. Revmaster took a look at the shaft itself first, and decided it needed some fixing. In a stock engine, all of the gyro forces from the prop go into the end of the crankshaft where the prop hub attaches to it. They then travel back through the entire length of the crank, and are absorbed and distributed through the No. 1 bearing which acts as a thrust bearing. Revmaster machines are new and much larger tapered prop hub mounting on the front of the crankshaft, and then transfers the radial loads and gyroscopic forces directly into the front end of the block by means of a new No. 4 bearing. In addition, a new and also much larger main thrust bearing is machined into the block at the No. 3 bearing location, where the beef of the block casting distributes the strain.

A floatless Tillotson carburetor, incorporating a built-in accelerator pump, is mounted below the engine, and two Slick aircraft magnetos are gear-driven off the flywheel end of the camshaft. On the other end is Revmaster's own prop hub. At present it starts life as a 33-pound lump of 4130 steel, and finished weight of the hub is only about 2½ pounds, so for mass production economy the hub obviously will have to be forging.

Finding a prop to suit the rpm and power ranges of the 2100-D might be a problem, so Revmaster manufactures its own, a fiberglass-covered wood unit of 63-inch diameter and 40-inch pitch. And waiting in the wings is something even better.

Early in the development of the aircraft engines, Revmaster engineers also began work on a constant-speed propeller which would be suitable for engines in the 65-hp

range. It is based on the standard oil-and-diaphragm principle, and the company had test units in hardware when development was halted to concentrate on getting the engines themselves on the market. Further work on the constant-speed unit depends, company spokesmen report, on the project being funded or on sufficient profits from the engines becoming available.

The 2100-D, complete except for propeller, weighs just 178 pounds when equipped with roller-bearing crankshaft. With standard babbitt bearings on the crank — which company engineers have decided work just as well as the more costly roller bearings at the lower rpm range of aero engines — the weight is just 160 pounds, or some 20 percent lighter than 65-hp Continentals which power so many J-3 Cubs, Aeronca Champs and homebuilts. Something else that is well below the competition is the cost: \$1,095 complete, ready to have a propeller bolted on one end and an airplane on the other.

The Revmaster plant is presently geared to produce one engine per working day, and each one shipped goes through two four-hour test runs on a calibrated stand, where thrust measurements confirm power output.

The 2100-D actually develops substantially more than 65-hp at its 2,800 rpm takeoff setting, but Revmaster prefers to publish the lower figure. Company officials have confirmed, however, that they plan to continue development and offer a 100-hp dual-ignition aircraft conversion in the future. Beyond that they do not plan to go, since certified aircraft engines in the 100-hp range already exist in numbers.

The 2100-D is not Revmaster's only aero engine: the firm offers single and dual ignition up-graded engines based on all three of the standard Volkswagen engine sizes available in the U.S. In addition to racing VWs, dune buggies, dragsters and aircraft, the firm also is developing a watercooled VW conversion for use in boats.

For details on the full line of Revmaster engine conversions write Revmaster, Inc., Box 525, Riverside, Ca. 92502. ●



It's All In The Formula

THE NIFTY LITTLE sports planes called Formula Ones are all designed and built to conform to rigid specifications drawn up for that race class. The very definite performance differences of these unique homebuilts are thus all the more interesting.

Very briefly, specifications for a genuine Formula One racer call for a minimum weight of 500 pounds, a minimum wing area of 66 square feet, and a stock engine of not more than 200-cubic inch displacement. (A complete rundown on the Formula One "do's and don'ts" comprises several pages of the fine print and these specs are available from the Professional Race Pilots Association, 16700 Roscoe Blvd., Van Nuys, Calif.)

It would seem that the greatest factor in equalizing the speed of all these airplanes to make this race class more competitive is the requirement that they use the same basic engine. A few modifications and alterations are allowed, but these are specifically spelled out in the rules.

The engine used unanimously by the Formula Ones is the Continental O-200 because it has the best available power to weight ratio. Although the Formula One engines are their greatest common denominator, engine performance is a big factor in their differences in top speed.

For example, Bob Downey's speed around the various race courses in Ole Tiger has fluctuated as much as 25 mph over the past three years through engine and cooling experimentation alone — with no changes in the basic airframe.

At the Reno races in 1971 when Hank Kennedy was Downey's crew chief, the engine was performing very well. Ole Tiger qualified at 227 and placed third in the main event at 219 mph. At the Wilson, N.C., races early in 1972, Downey won at 216 mph and a few weeks later at the Transpo '72 races, he qualified at a peak 231 mph. Later in the year at Reno he was still going hot, and placed second with a 219-mph speed in the main event at Miami in January, 1973.

A few weeks later in Palm Springs, Downey established a new speed record for this class airplane at 259.3 mph. (It must be remembered that this speed was established during a two-way run over a 15-mile straightaway, per FAI/NAA rules, thereby showing a much higher speed than on the 3-mile rectangle used for closed course racing. In fact, different courses can distort the speeds shown by all contestants in a race. If the pylons are positioned so that sharp turns are required, all entrants show a slower speed.)

After Downey's Palm Springs record run and a crew change, some modifications were made to Ole Tiger's engine that were not discovered until about a week before the Reno race. Another new crew had taken over the care and feeding of Ole Tiger, which included an engine that no longer had the right combination. The best Downey could do at the 1973 Reno races was 209 mph, not fast enough for the main event.

Downey says the poor performance was due to improper magneto timing, carburetor adjustment, and a new air intake that evidently did more harm than good.

Bill Lamere worked on the engine cooling after the Reno races and, according to Downey, "improved it 100 percent." Downey said, "We copied Bill Falck's engine baffling and George Owl's air intake around the prop, which pressurizes the engine compartment so that the air exhausts over the top of the cowl. The airplane runs the coolest it ever has and the oil temperature stays lower. So his work on that portion of the airplane was very fine."

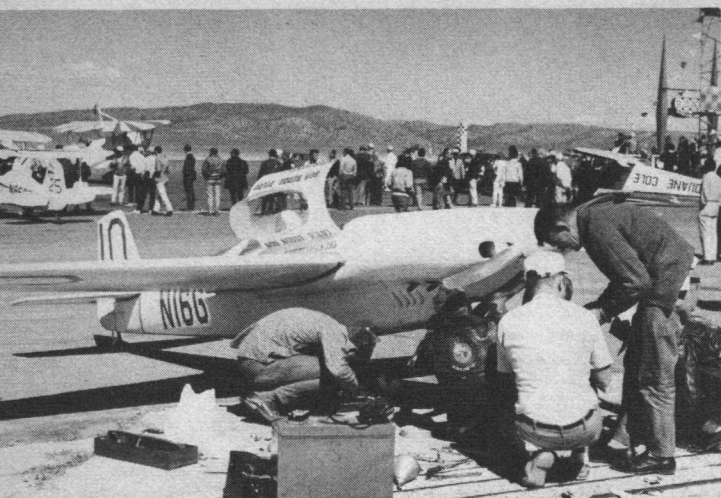
Downey's Ole Tiger, the former Miller Special, has distinctive flight characteristics, not all of them desirable.

The airplane is 17 feet long, has a wing span of 14 feet with a very deep chord, and the required 66-square foot wing area. It weighs only 540 pounds and, because of its comparatively light weight in the Formula One class, should be one of the first off the ground.

But Downey explains that Ole Tiger does not have a high lift wing — it has a high speed stall wing. He says the airplane can be stalled out at 200 mph by pulling back on the stick too fast, or if the G load builds up.

The airplane is very sensitive, much more so than a Cassutt racer, for instance. Due to its low stability margin, it will change direction with only slight movement of the stick and rudder. Downey says that when he first bought the Miller Special he had to lean his hand against the instrument panel to keep the airplane from oscillating. The control surfaces were minimal and the airplane porpoised badly. Downey followed Art Williams' and Curtis Pitts' advice to add three inches to both the horizontal and vertical stabilizers, and controllability was greatly improved.

In a last-ditch effort to improve their speed before the Quaker State Grand Prix races in Southern California in the fall of 1973, Downey and his crew removed the extra three inches of surface. Downey flew the airplane twice and found it so directionally unstable that the surfaces were returned



Bobby Budde's Frenzel Racer is typical of the new class of Formula One racers now polishing pylons at big air shows.

to their improved configuration. Luckily for Ray Cote, the new wing he and his crew built and installed for Shoestring just before the '73 races at Reno worked well the first time around. The new wing was test flown on Shoestring shortly before the races, and there was no time to make modifications.

Although Shoestring had won the National Championship race five years in a row, competition was getting tougher. Cote and friend and aeronautical engineer Ken Stockbarger designed the new wing and were pleased to note that not only was the airplane faster, but Shoestring's already outstanding handling characteristics were further improved.

Cote reported that the new wing was more stable — the airplane had better maneuverability and stability, the speed decayed less in the turns, and stalls were "clean as clean can be."

The wing has a fairly high aspect ratio and was designed for optimum performance around a three-mile race course. Stockbarger says, "We tried to go to a modern section and extreme taper ratio to get rid of as much wetted area as possible.

"We got a real break with the new wing," he added. "It isn't sensitive to pilot weight. We can stay at 8 percent, which is the max forward according to PRPA. The pilot could weigh just 50 pounds and still stay within the forward limits, or he could weigh 450 pounds and not exceed the 25 percent maximum aft allowance."

Shoestring weighs the same with the new wing — about 160 pounds. The new wing is thinner, but has a bigger span and the same area as the old wing (about 66.1 square feet). It is interesting to note that Shoestring exceeds the minimum weight of 500 pounds by some margin. The only other popular Formula One heavier than Shoestring is Rivets, a steady winner in former years until Shoestring took the lead.

Stockbarger points out that weight doesn't mean much at speed, only for acceleration for takeoff — the lightweight airplanes get off the ground quicker. But a faster, heavier airplane can build up a head of steam and use up less energy in the turns.

Shoestring is an aerodynamically "clean" airplane, and the crew is constantly working to improve its drag coefficient. "We are always trying to take out one more drag count, now down to about 140. Shoestring is so clean it has to be slowed down to land, or it would just keep right on flying."

Cote has made many changes in Shoestring since he purchased it in 1967, but both Cote and Stockbarger show great admiration for Rod Kreimendahl's aeronautical design genius as evidenced some 25 years ago when he drew up the plans for Shoestring. "It's not difficult to take a good airplane and make it better — not nearly as difficult as taking a dog of an airplane and trying to make a winner out of it. As a designer, Kreimendahl was unique, and not far from being right. All we have done is add a little modern technology. For what he had to do, with what he had to do it with, he did a fine job. We didn't know as much then about aerodynamics as we do now — the principles hadn't been proven.

"In the Formula One group, there are a lot of people involved and dedicated, and I can't say that Tom Cassutt, or Art Williams, or George Owl, or anybody, as a designer, is wrong. We happened to put together a winning combination. There is a feeling that if you don't win, you're wrong. How far wrong are the others? About two seconds around a three-mile course!

"The only individual effort is by the pilot on the course during a race. But it's the team that works together and puts the airplane together that really counts. There is no individual who can take all the credit for making an airplane go."

At Edwards Air Force Base, there's a pretty high-powered team who are the new owners of Harvey Mace's Formula One design, Shark. Partners in the racing venture are both USAF Colonels: Bill Skliar, who is assistant deputy commander of operations at EAFB Flight Test Center, and Ted Sturmthal, who is the Air Force pilot selected to fly the new generation tactical bomber, the Rockwell International B-1. After buying Shark, these newcomers to the race scene received the airworthiness certificate for the airplane on a Friday, Skliar flew it for the first time the following Saturday, and spent the next two days flying to get his required 10 hours. On Monday they put it on a trailer and headed for the '73 Reno races.

Skliar and Sturmthal are pretty well convinced that Shark is a strong airplane. "At Reno," Skliar said, "I went into the same dust devil that knocked one of the other boys out of the race. It rolled the airplane from the left turn around the pylon to the equivalent bank in a right turn. The push-down of negative Gs was so severe that I hit the canopy with my helmet, and it was sustained long enough so that my engine coughed from fuel starvation. I don't know how many negative Gs I pulled, but there was no damage at all to the airplane — which impressed me pretty well."

Skliar's flying background is all military and even the smallest military aircraft, the T-38, seems like a truck compared to Shark. Skliar says that Shark is stable but sensitive, with no tendency to PIO (pilot induced oscillation). "We've seen some of the birds on the straightaways with the nose seeming to wander up and down, but Shark has very

good characteristics — no drifting around the pylons, no problems at all as a matter of fact."

Except for changes in the rudder pedal and brake pedal system, Shark is in essentially the same configuration that Mace first raced in 1970. Skliar feels the airplane has never been optimized and has a lot of potential.

Another Harvey Mace design, No. 98, is presently owned and flown by veteran pilot Bud Pedigo who modified it extensively from the original configuration.

Formerly a shoulder or high-wing airplane, Pedigo had to make it a low-wing airplane due to updated visibility requirements. This major change, plus cleaning it up here and there, installing a different canopy, propeller, spinner, and wheel pants, actually was equal to rebuilding the airplane completely.

Pedigo's second major modification included lowering the landing gear to a new configuration, and changing the canopy again, all the fairings, switching the cowl to fiberglass, adding annular-type cooling, and increasing the wing area. All of these improvements took the airplane from the 160-mph class up to about 210 mph.

Pedigo reports the airplane is very sensitive at slow airspeed, but otherwise has good flying characteristics. "I haven't flown too many of the Formula Ones," he says. "But some of them you have to go kind of easy in the turns, and some you can rack around pretty hard. I happen to have an airplane that you can wrap around pretty hard and it doesn't seem to slow down too much. Consequently, I can roll up pretty tight on the pylons.

"When I flew No. 87 for instance, it was a faster airplane and you had to fly it a lot differently. When I first flew No. 87 it would lose about 40 mph in a turn — I wasn't flying it, I was driving it. I was accustomed to flying my airplane, where I can run right up to a pylon, just squeeze it around and go on.

"Because it was a faster airplane, No. 87 had completely different flight characteristics, and I found I just couldn't fly the same way. I had to learn to fly a much larger radius turn without losing speed. When I mastered doing that, the airplane started performing very well for me, but for a while I didn't realize what was happening."

Pedigo hopes to improve his own No. 98 with wing root fairings, a different spinner, possibly a different tail wheel, and tighter fitting wheel pants — an entire "clean-up" project via tuft testing.

Even with a brand new design, refining and improving is a continuing process. Loki, an original design by Ernie Prosch, made its debut at Reno in 1973 after two and a half years in the workshop.

Bob Reinspeth qualified Loki at 198.5, which wasn't bad for the first time out, but Prosch immediately began a program to improve performance. He had built parts for four airplanes at the same time, with the long range plan to develop a really successful racer and market the plans and a kit for homebuilders.

Aside from getting the weight down from its present 595 pounds, Prosch plans to relocate the c.g., which is slightly forward on the prototype. He is experimenting with lead weights in the tail to see where they work best, then will

locate the engine farther in toward the firewall on the next airplane.

Prosch is refining the engine, and is planning to change propellers. "This prop did better at the Reno altitude than it did at the sea level races at Miramar," Prosch said. "We have a 58-inch diameter and a 64-inch pitch, and I think we should come down two or three inches in pitch and try a 58:61 or 58:62. This prop just loads down the engine too much and it doesn't have enough power. Ray Cote and John Paul Jones have developed their engines until they are getting almost the ultimate in horsepower and they can swing the big props."

While most other racers are wood or tube steel and fabric, Loki is metal, all monocoque structure, has a wing span of 18 feet and length of 19 feet. A larger-than-usual canopy allows for Prosch's 6 foot 3 inch-frame, which is taller than the average race pilot. A sweptback tail is featured, to which Prosch attributes the airplane's excellent longitudinal stability.

"There were three reasons for the racer's swept tail," Prosch said. "One is for aesthetic value — it looks good. Number two, it moves the yaw action on a greater arm aft of the airplane, thereby increasing the stability. Also, this particular swept tail was easy to fair into the fuselage. The whole airplane is faired quite well to keep the drag down."

Prosch himself raced Loki for the first time at the Quaker State Grand Prix races at Miramar. He flew in a very conservative manner the first day, but the second day was flying the pylons well, still staying a bit high and wide until he had more experience.

Prosch says the aircraft is exceptionally stable in all three axes. "John Paul Jones flew it at Reno and said it is almost too docile to be a racer," he commented. "It stalls beautifully, rolls beautifully, flies fast, and is a really good sport plane.

"The airplane does go faster with Jones in it — not because he weighs less than I do, but because of his greater flying skill. He really knows how to make an airplane go around the pylons, and was clocked at Reno at 210 mph. That indicates that speed is not all in the airplane and the engine,



The Cosmic Winds set new standards in Formula One racing after World War II, when pilots like Vincent Ast raced.

it is also a function of the pilot, and there can be a lot of difference."

Vince DeLuca has become a pylon polisher of the first order in the few years since he started racing. At the Miramar and Point Mugu races he displayed top notch piloting technique — outflown by no one.

Li'l Quickie, as Vince calls his Owl racer, has become a special project for old master George Owl himself, who works on the airplane alongside DeLuca to improve it.

No two Owl racers are identical, just as each Cassutt racer includes ideas from the individual builder, and Li'l Quickie is the quickest yet. DeLuca says, "My airplane differs in that it has a very long wing and very short fuselage. By shortening the fuselage we cut out the wetted area and at the same time cut down weight." N1VD, as it is also known, has a span of 20 feet, length of 14½ feet, and weighs 550 pounds.

"As to general performance characteristics of the Formula Ones, if you can make one weigh 500 pounds, it will come off the ground quicker than one that weighs 600, but that doesn't mean it will have a faster top speed.

"Span loading enters into the picture also, and I think it has something to do with altitude. At Reno, the short Cassutt wings don't seem to make it as well as the long wings. Cote had a longer wing this year, and he broke a record. He has a much thinner, longer, and completely different airfoil. He had a 23,000 series, and a new generation airfoil which goes from eight percent to six percent — it's really very sharp.

"I saw his new wing in its infancy when it didn't have ailerons on it. He had designed that wing originally with spoilers, but nobody could say exactly how it was going to handle at low speeds, so they put on ailerons and didn't even try it with the spoilers. That would have been a slick wing with the spoilers, because it would have had no trailing edge that drooped. I would have liked to try it.

"It's good balance that counts in maximum performance — light weight, top horsepower, good working propeller, and good airplane design."

Art Williams, designer of Formula One racer Stinger, puts it this way: "The flight characteristics of any race plane are the outcome of five factors — the airframe has to be aerodynamically clean and low in weight, the engine has to be putting out maximum power obtainable for a stock engine, the propeller has to be using that power efficiently, and the pilot has to be expert enough to fly a good race." Williams is capable of stating all that in mathematical equations which are incomprehensible to ordinary non-aeronautical-engineer mortals.

"Basic design has to do with weight, parasite drag, wing span, and wing design. Wing design has very little to do with getting off the ground, but a lightweight airplane will have better acceleration. The heavier an airplane, the more it slows down around the pylons; it needs extra span. Bill Falck's Rivets is very heavy, but has a shorter wing span. His airplane is slow in accelerating and takes a while to build up speed. It's a compromise either way.

"Aside from acceleration and getting off the ground, Downey's Ole Tiger is pretty difficult to fly. It's getting better since he put the longer tips on the tail. He found out

that adding more area to the tail wasn't the answer, it was adding more span to get a higher aspect ratio that helped make it more stable.

"In the early days of Formula One racing, Howard Terrill kept adding more tail area by extending the chord on Shoshonick and it didn't help much. When Sol Lanese bought the airplane, he took my advice and extended the span on both the vertical and horizontal stabilizers. After he flew it, he said it was almost as stable as his Cassutt.

"My airplane, Stinger, isn't as light weight as the Cassutts, it's somewhere around 570 pounds. Wittman got clear down to 507 pounds with the wire braced wings, and some of the builders of the thick wing Cassutts also got the weight down that low. Deerfly weighed only 500 pounds. But if they have shorter span, they still don't do so well at high speed in the turns.

"Stinger takes off fairly well and then, of course, it goes fast and is doing better all the time. We have a fairly good size span of 19 feet and a good wing plan form, but not the lightest weight. The reason we don't have the lightest weight is because we put in extra strength to make it a 12-G ultimate load factor airplane. We also put in extra tubing around the pilot to protect him in case of a cartwheel or ground-loop. All the safety features we have in there cost us another 25-30 pounds."

Williams also designed Estrellita, one of the top airplanes when the race class first began. "The specifications were originally drawn up in 1946 for the 190-cubic inch racers, as they were called then, and required a minimum wing loading of 12 pounds per square foot. A person didn't really know how heavy his airplane was going to turn out, so he usually made it a 71 or 72-square foot wing area, based on whatever his weight was estimated. Usually the weight was more than he thought, and he didn't pass the 12-pounds per square foot requirement.

"The following year the rules committee decided that wasn't a very good rule because they didn't want to disqualify everybody. So they took a minimum weight of 500 pounds, added the weight of the pilot and the 15 gallons of fuel then required, and figured out what wing area he could get along with. The figure they arrived at was 66 square feet, and it has been that way ever since."

The race class was created right after the 1946 Cleveland National Air Races at a meeting of the West Coast members of the Professional Race Pilots Association — Tony LeVier, Art Chester, Fish Salmon, Benny Howard, John Thorp, Irv Culver, Bill Robinson and others — a total of about 20 air racing enthusiasts.

The '46 races at Cleveland, the first to be held after World War II, had included events only for war surplus craft, P-51s, P-38s, Corsairs, etc., the only sport, high performance jobs available. The West Coast group saw the need for new, custom-built craft to provide an interesting, safe, and highly competitive race class.

For the pure excitement of closed course competition, many people feel that the little Formula One racers present the ultimate of interest and intrigue — especially to the designers and homebuilders who try to find the right formula.

